Evolution of recombination under partial selfing

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Team Evolutionary Biology and Ecology of Algae (IRL 3614)

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SelfRecomb project

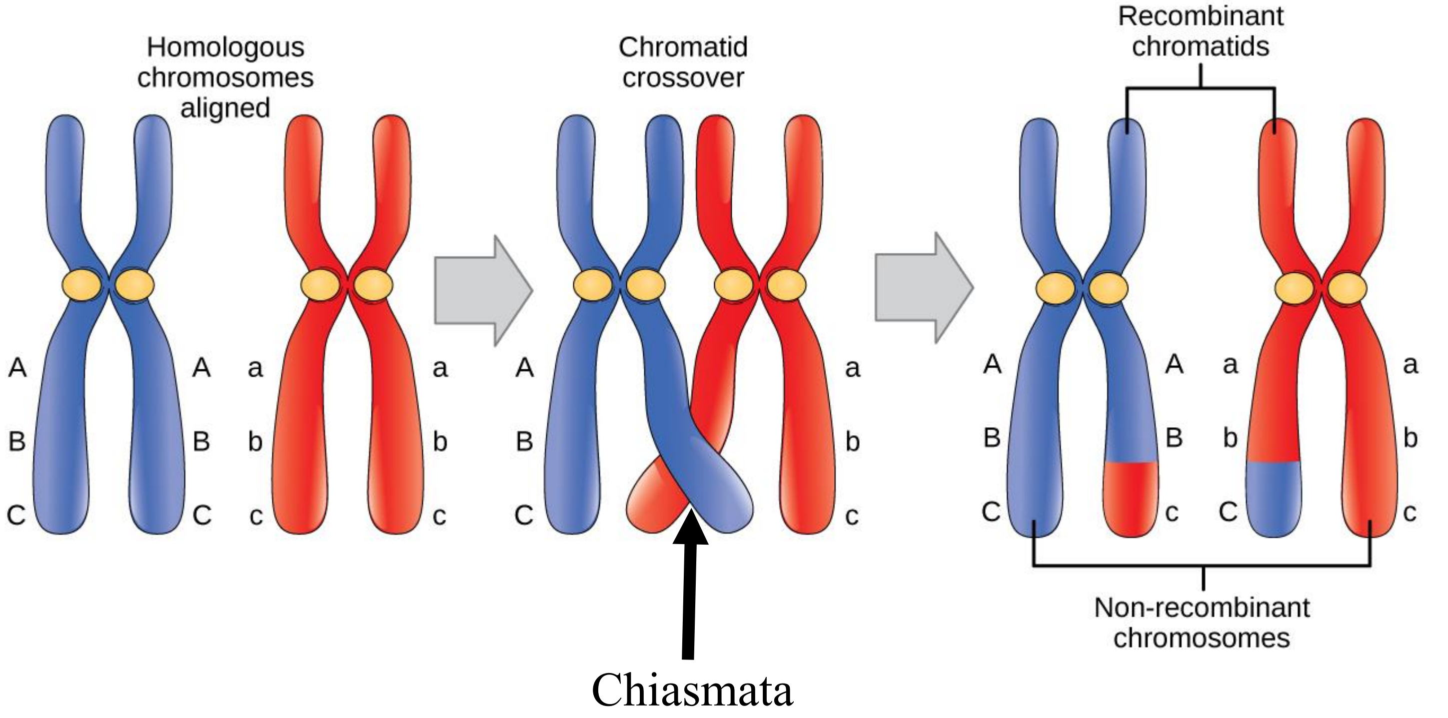
Context

Meiotic recombination:

→ One of the main advantages of sexual reproduction in Eukaryotes

→ Variable at many scales (chromosome, individuals, sexes, population, species, etc..)

→ Increasing knowledge on its genetic basis (reviewed by Zelkowki *et al*., 2019)



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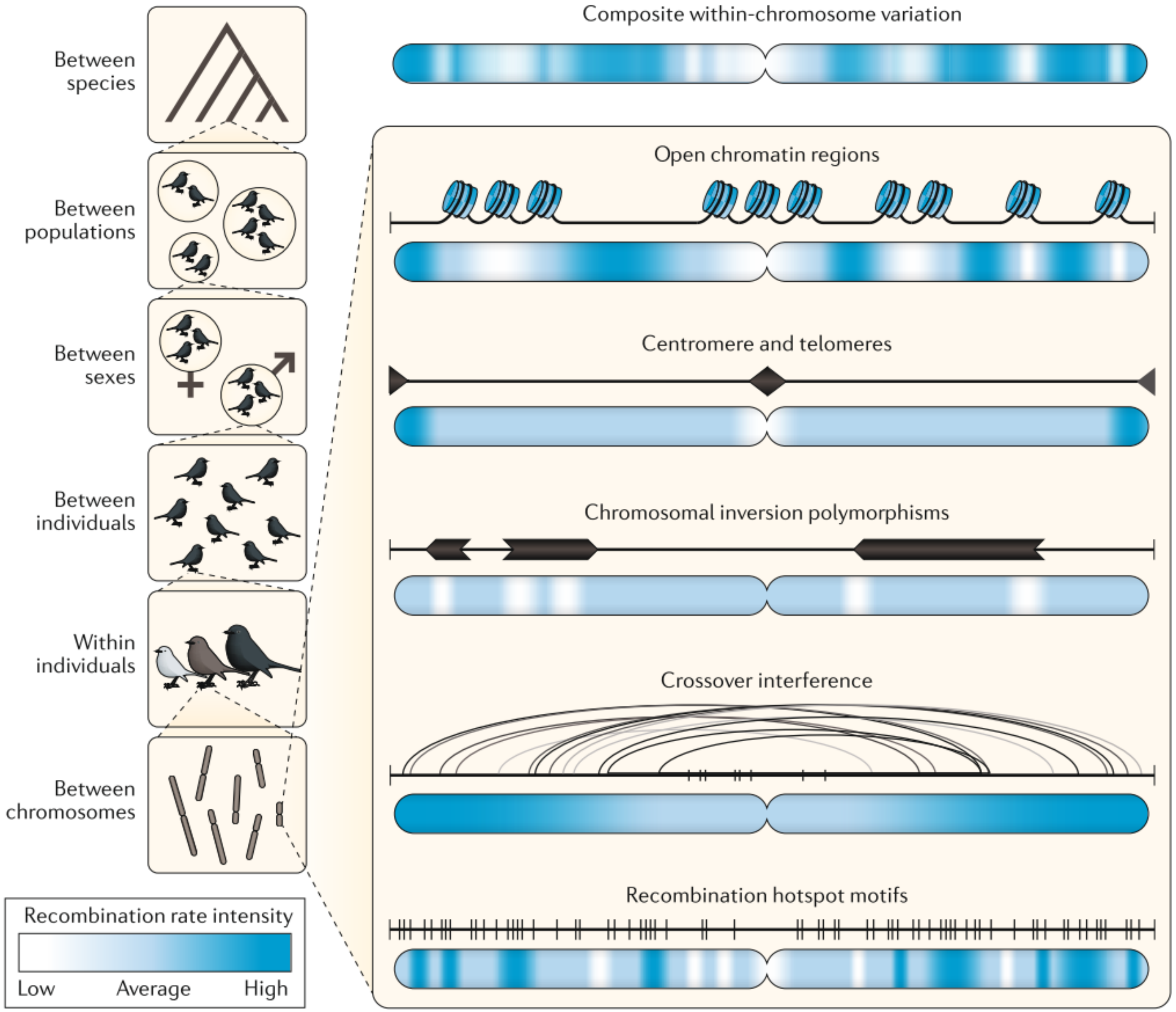

Peñalba &Wolf, 2020

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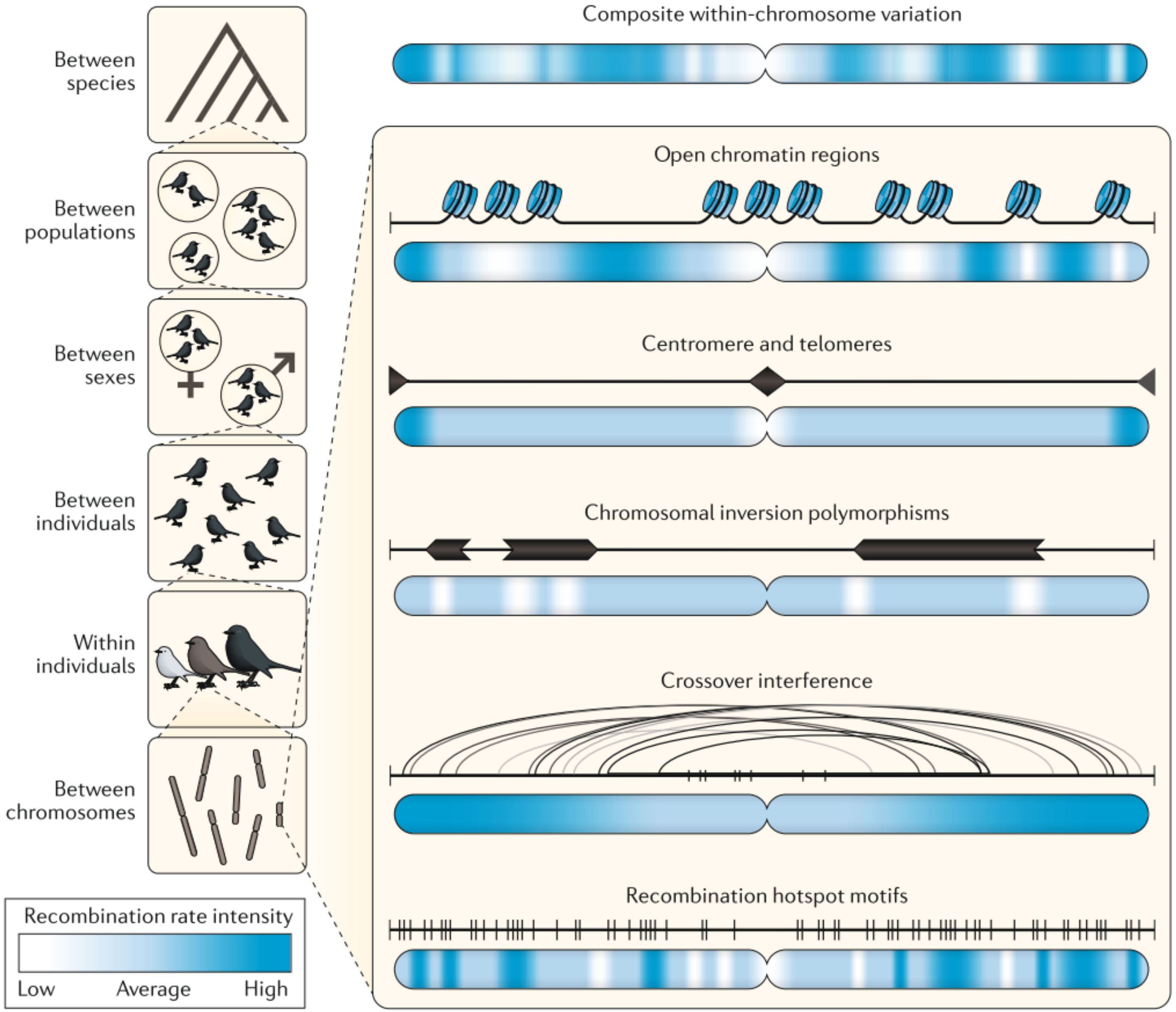

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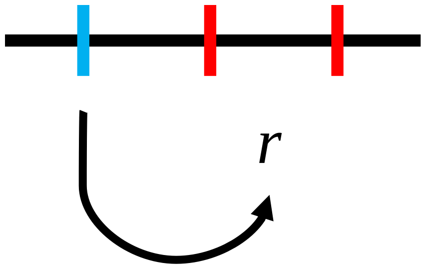
Context

Selection on recombination rates:

→ Direct *e.g.* proper chromosome segregation during meiosis

→ Indirect = mixing role of recombination

Recombination modifier models (reviewed by Otto, 2009) :



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→ Recombination is favored in finite populations by the Hill-Robertson effect (Keightley & Otto, 2006)

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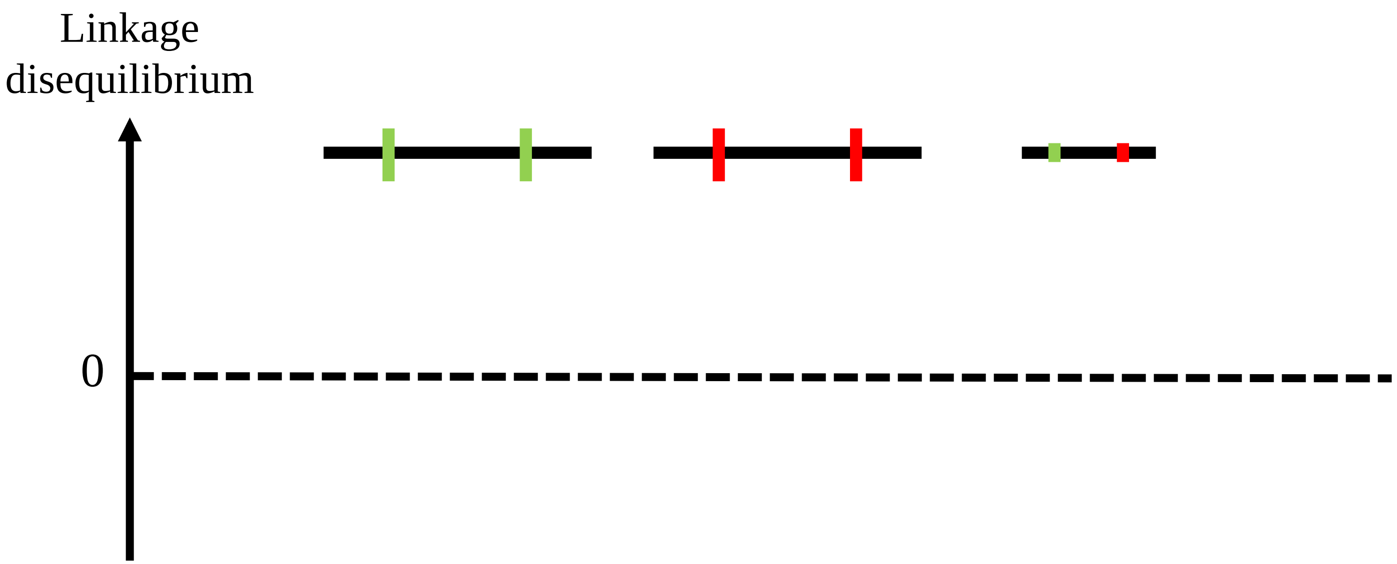

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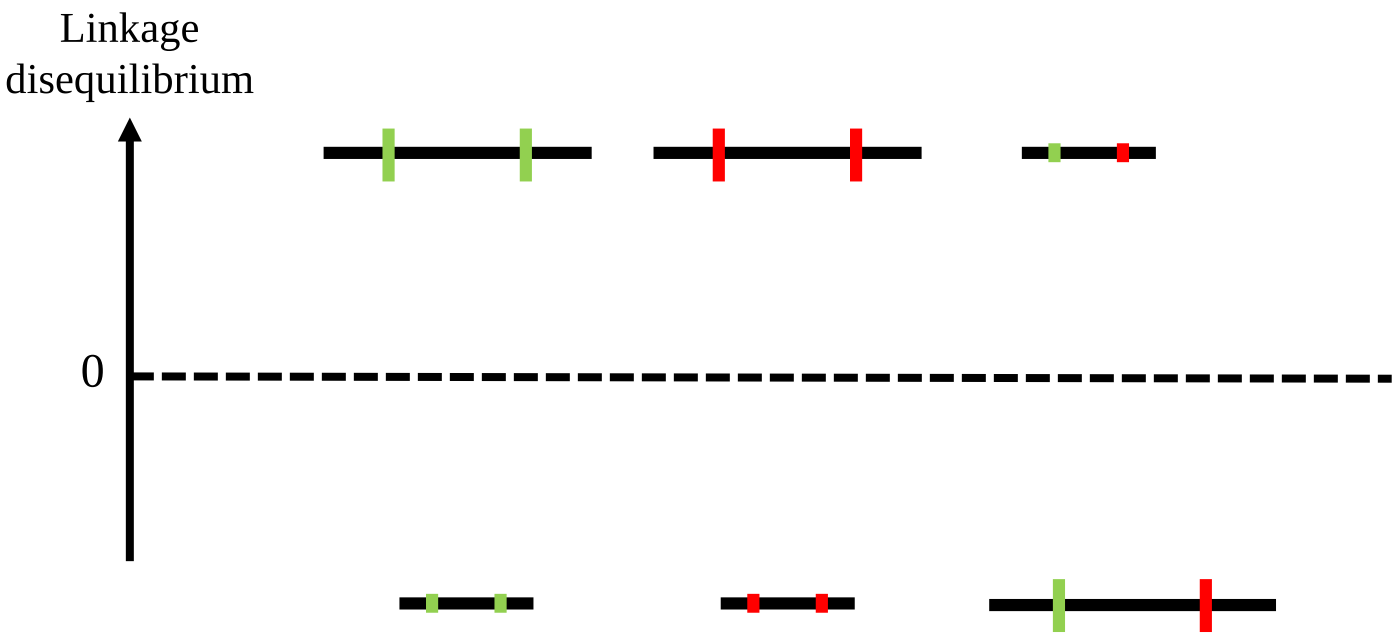

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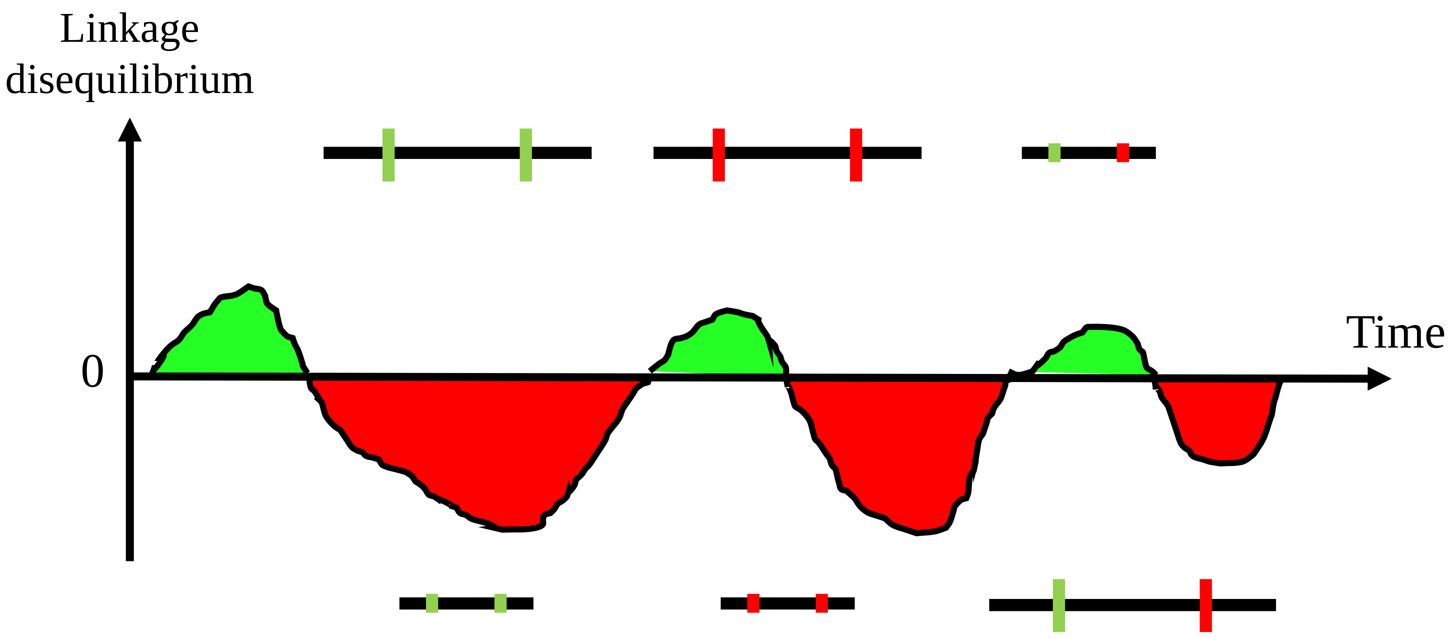

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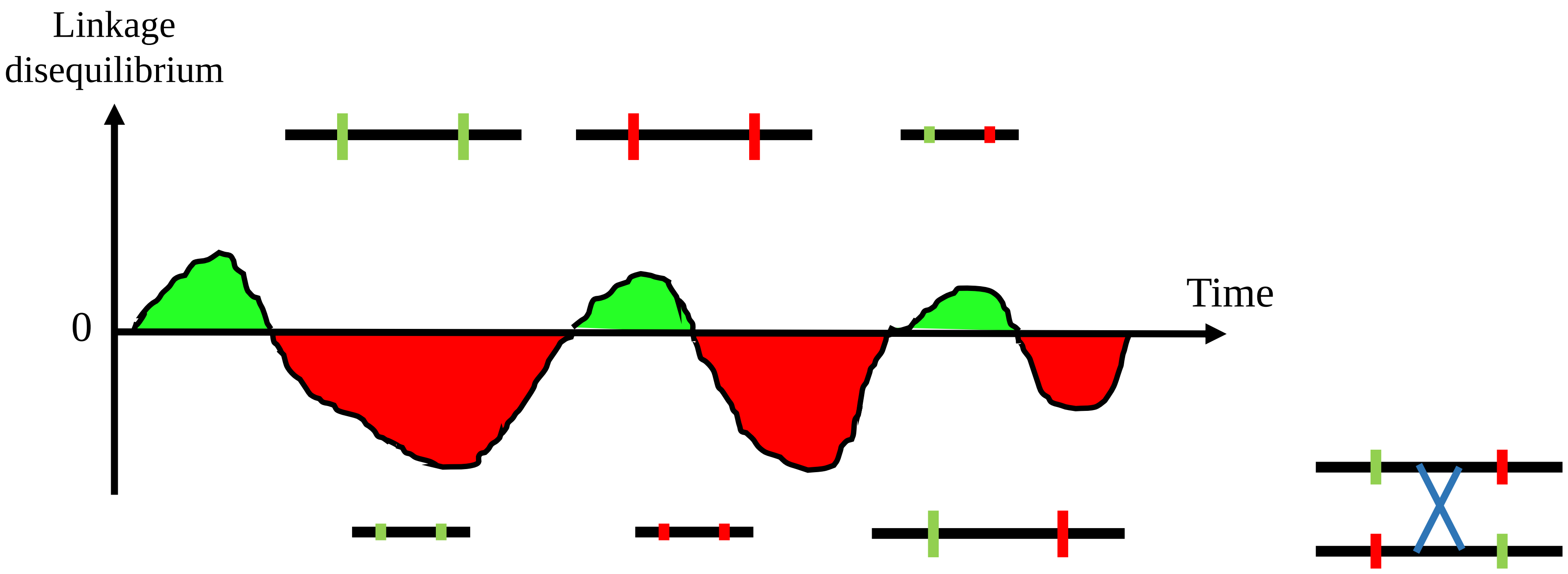

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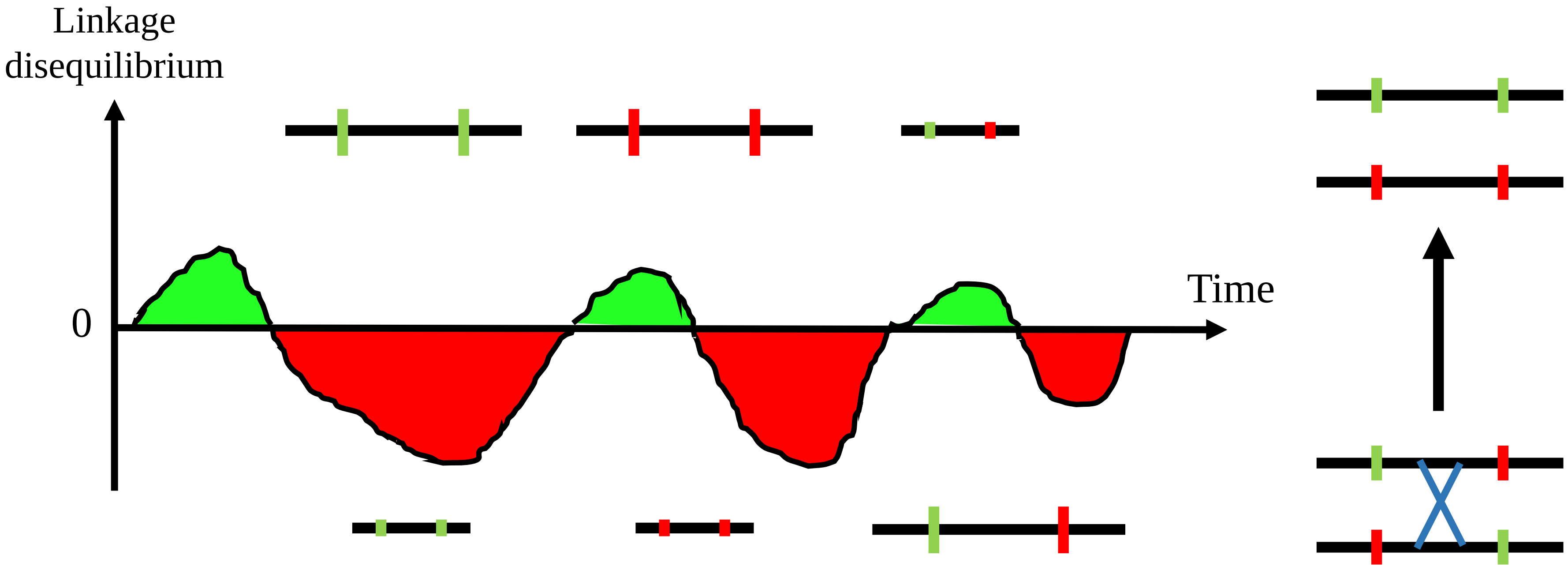

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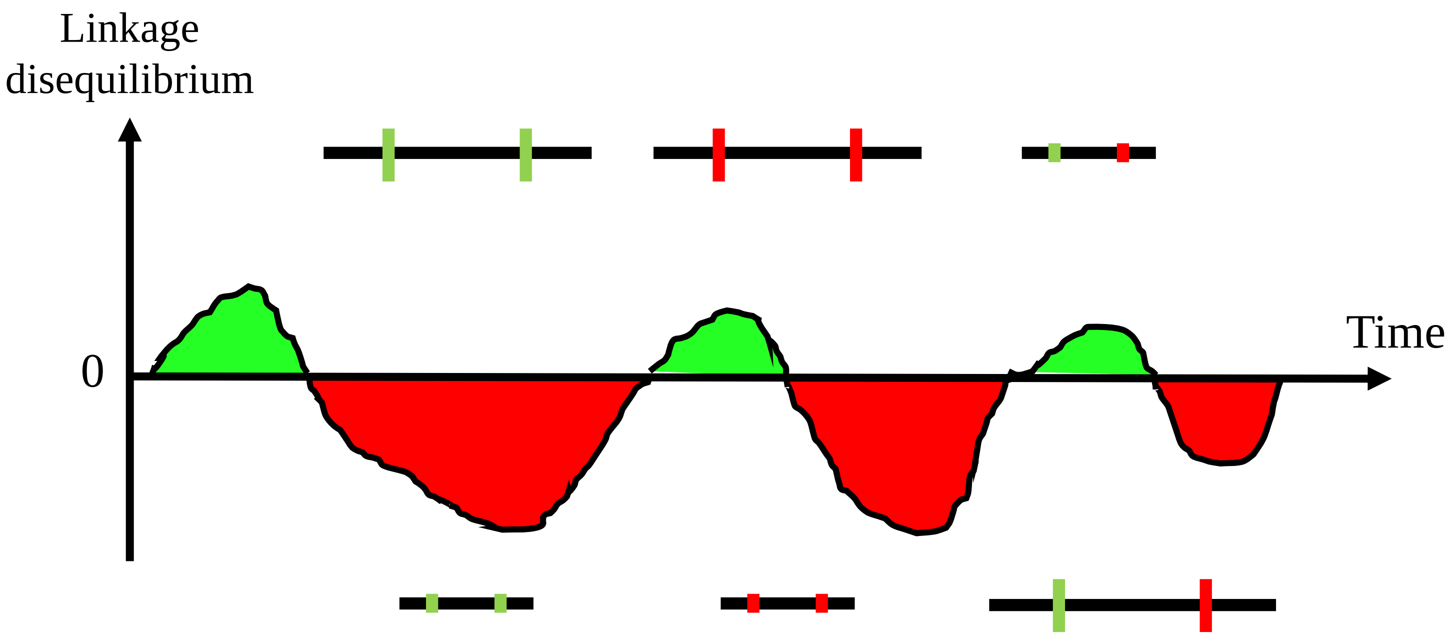

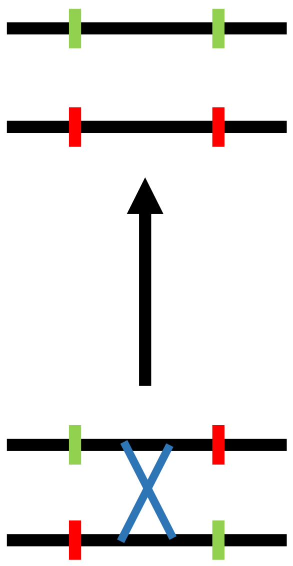

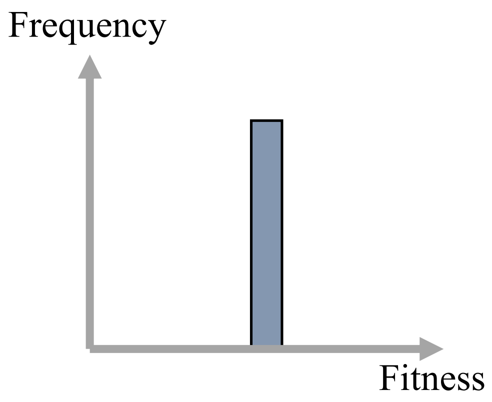

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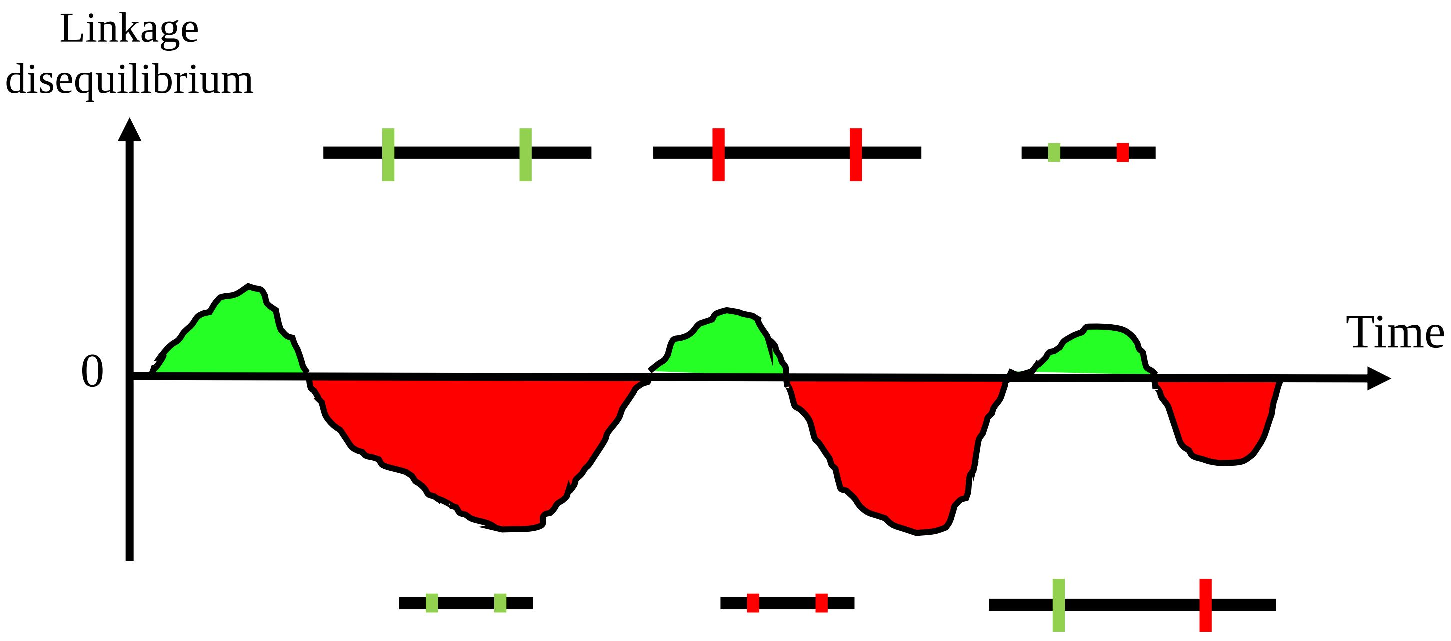

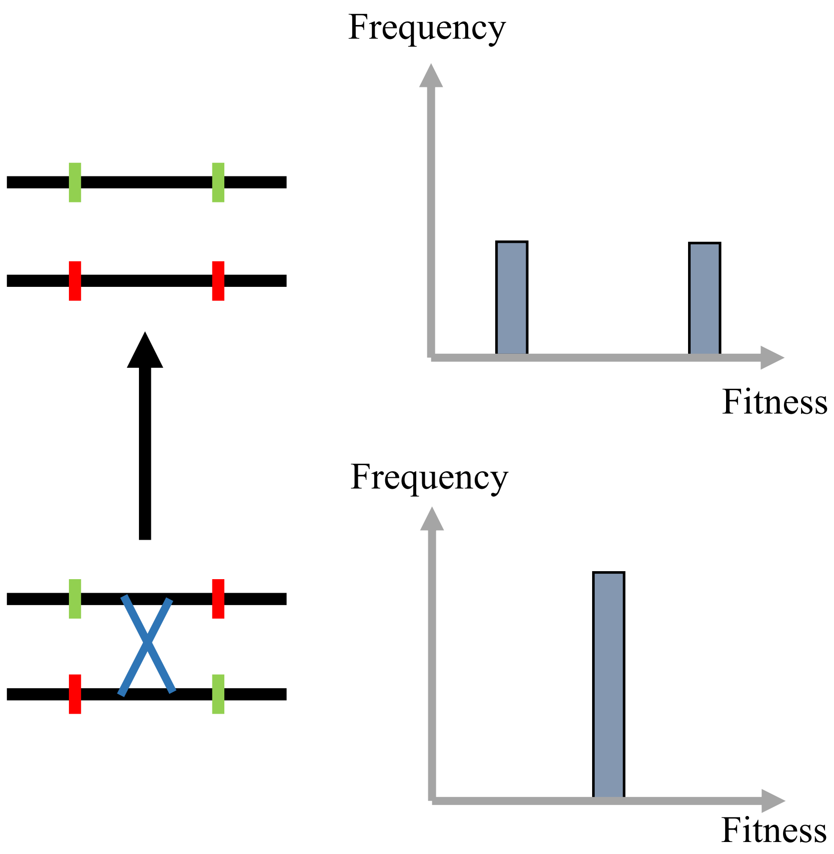

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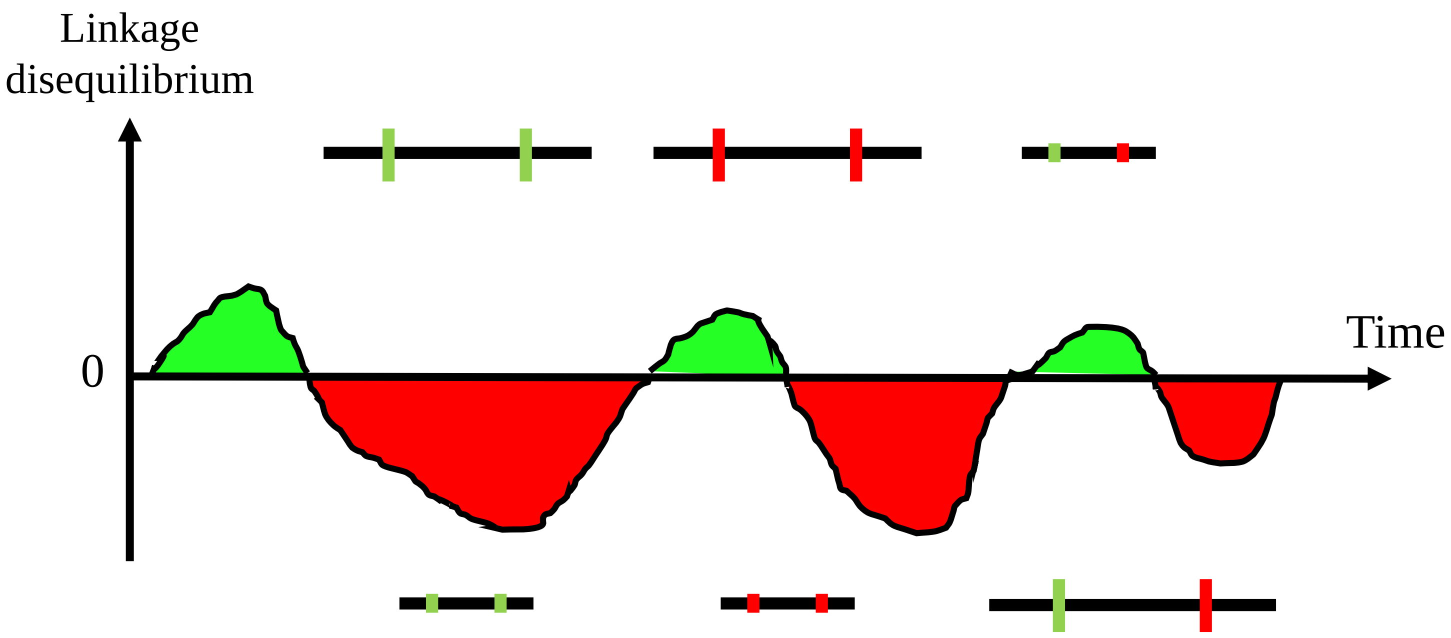
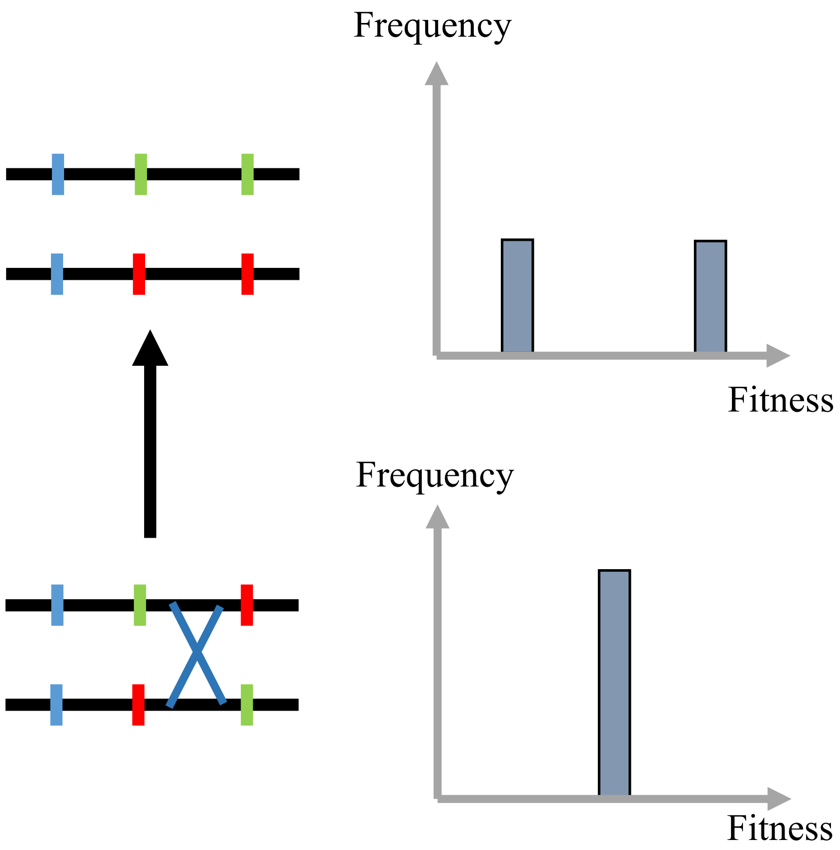




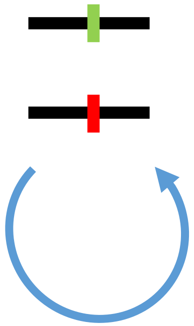
Context

The role of self-fertilization

Intuitively selfing:

→ Increases the variance in fitness

→ Decreases the efficacy of recombination



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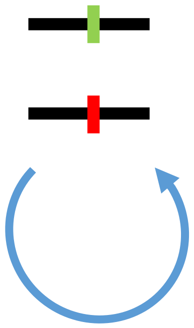

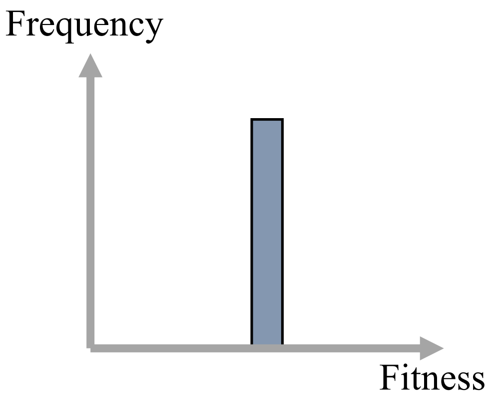

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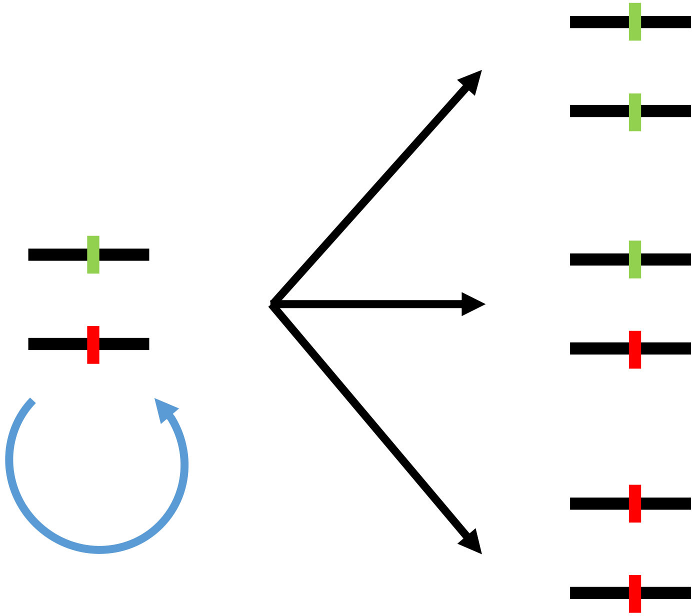

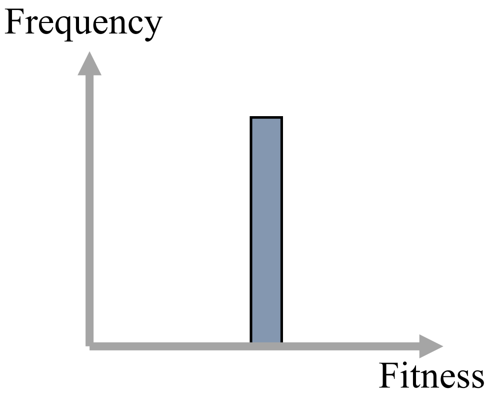

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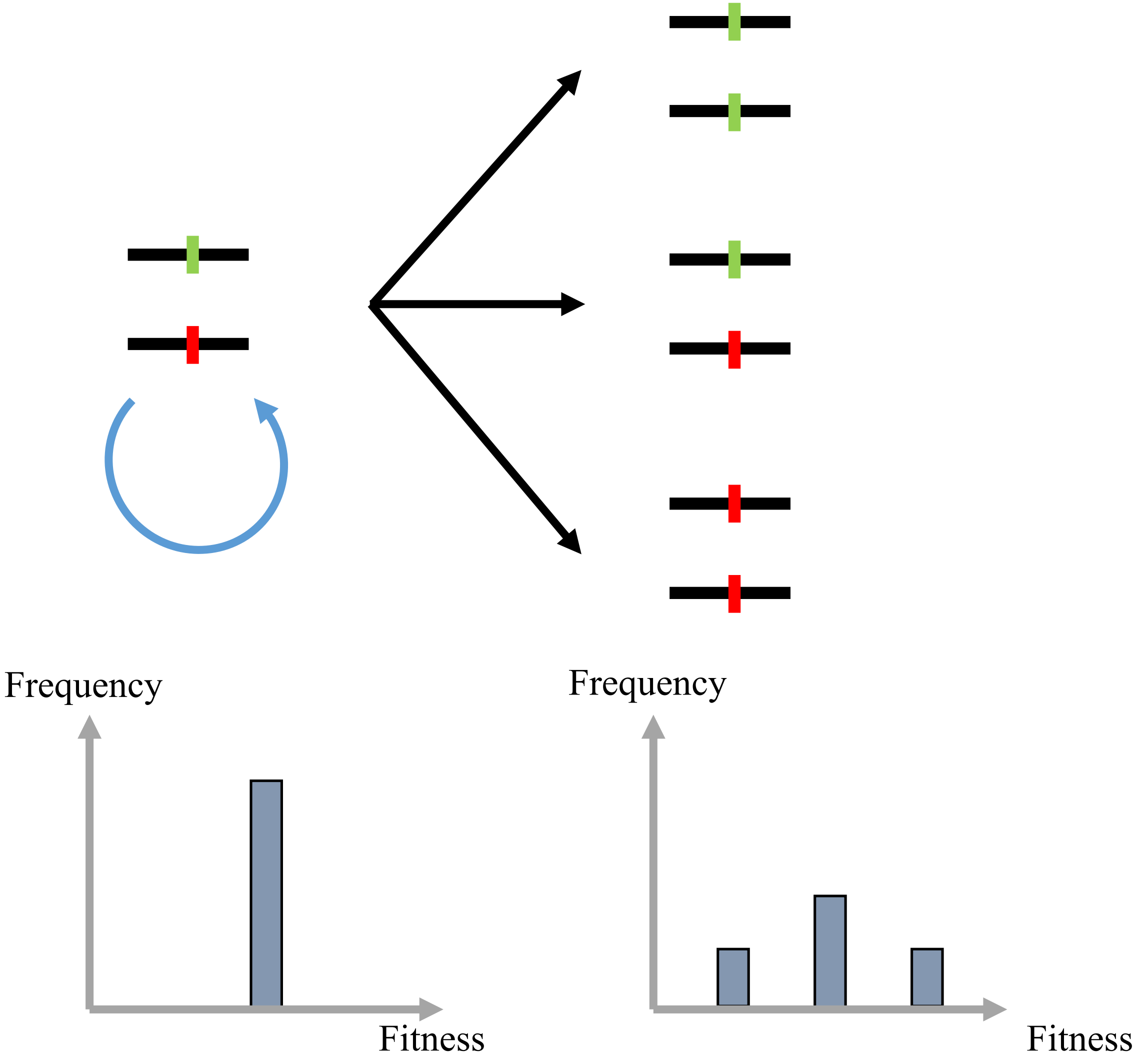

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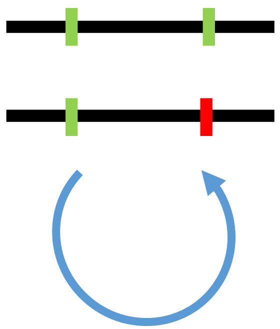

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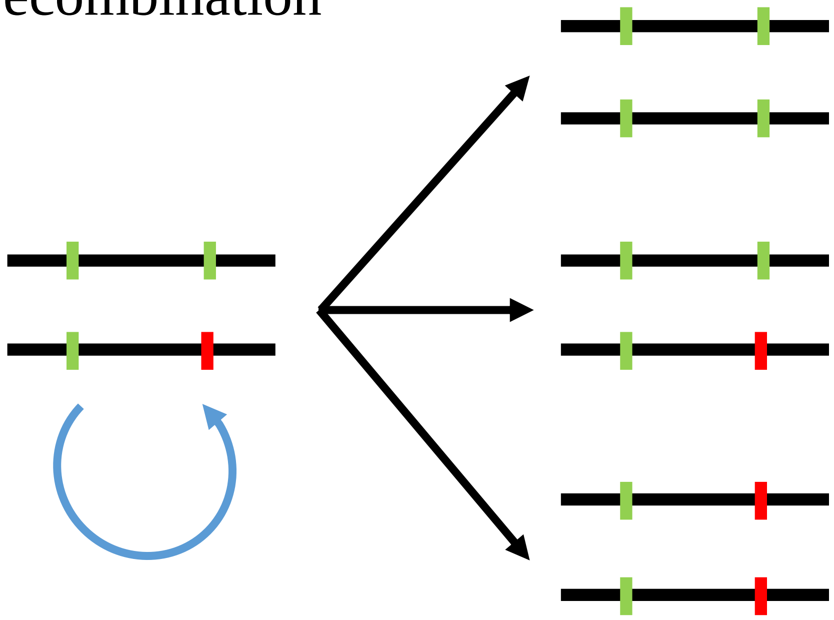

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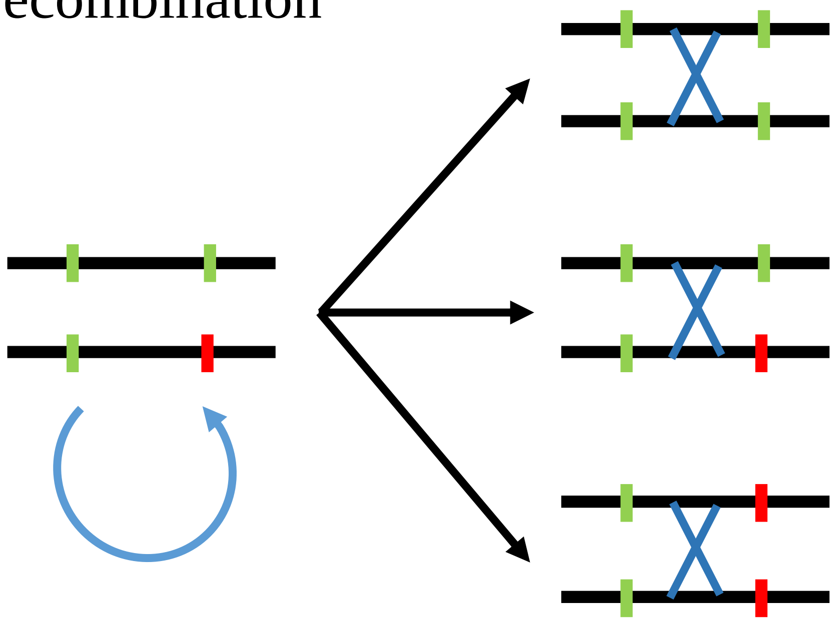

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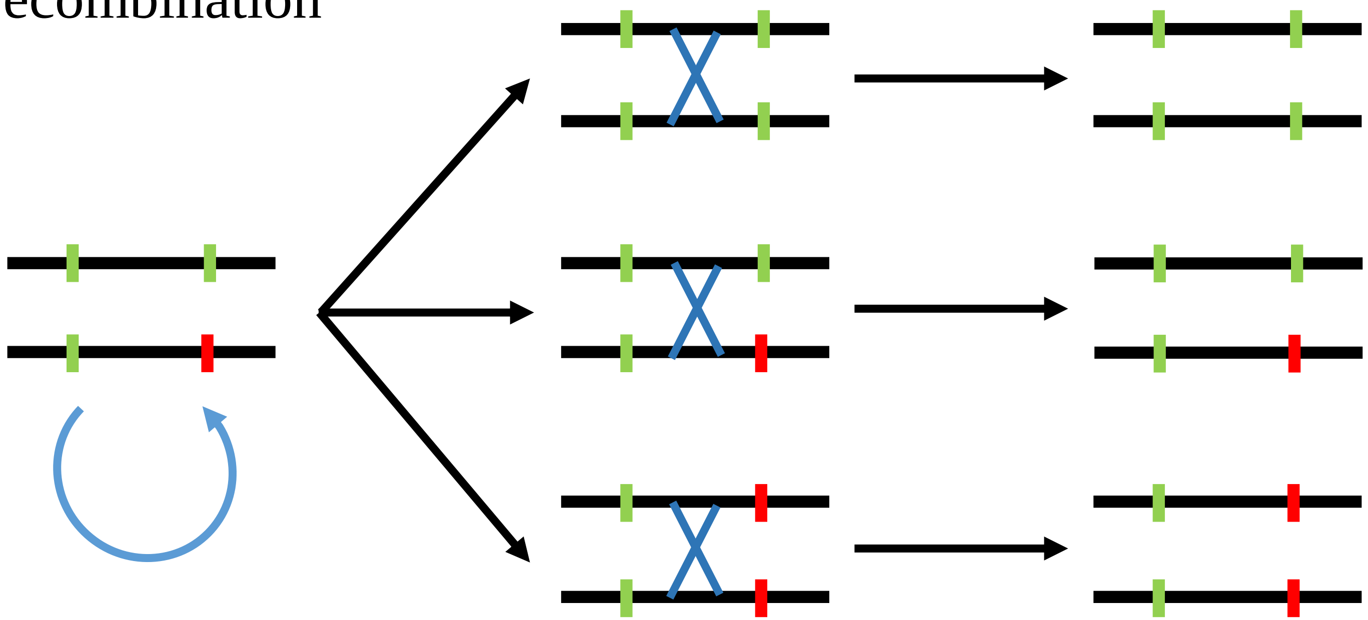


Context

The role of self-fertilization

→ Deterministic analytical model by Roze & Lenormand (2005): recombination is favored with certain gene interactions (disfavored otherwise)

→ QLE approximations require: $s << r$

→ Approximations break down when selfing rates are high and/or for tightly linked loci

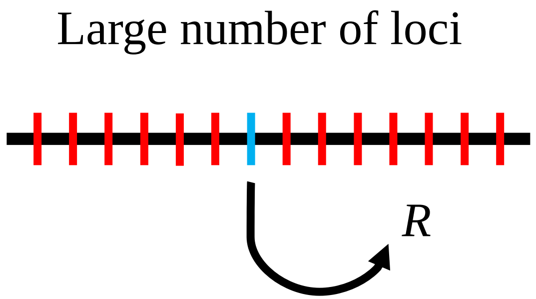
Model

→ Reanalysis of Roze & Lenormand's model with weak recombination and only deleterious mutations

→ Adaptation of the stochastic model of Roze (in press) to include the Hill-Roberston effect with selfing

→ Whole chromosome introducting a chromosomal mutation rate U and a direct fitness cost of recombination c

→ ES map length R_{ES}



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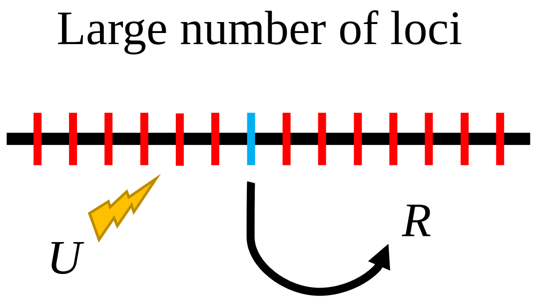

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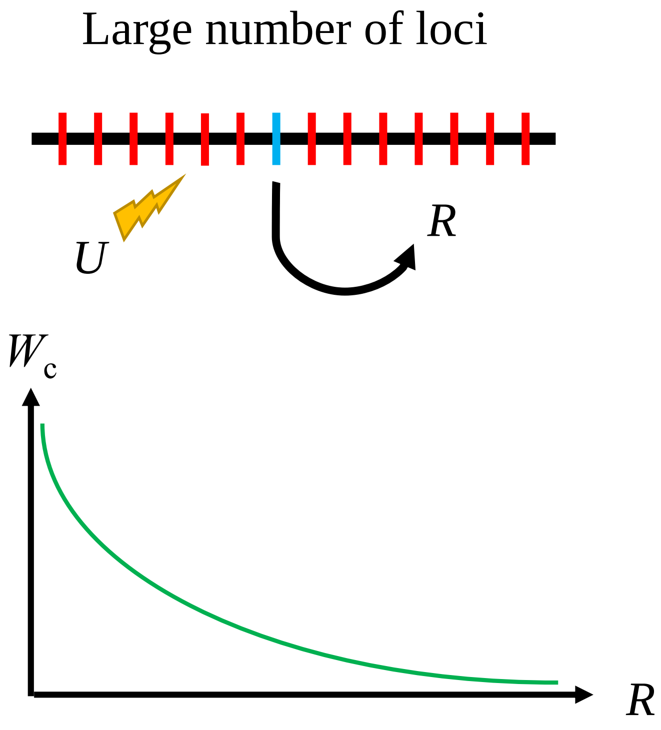
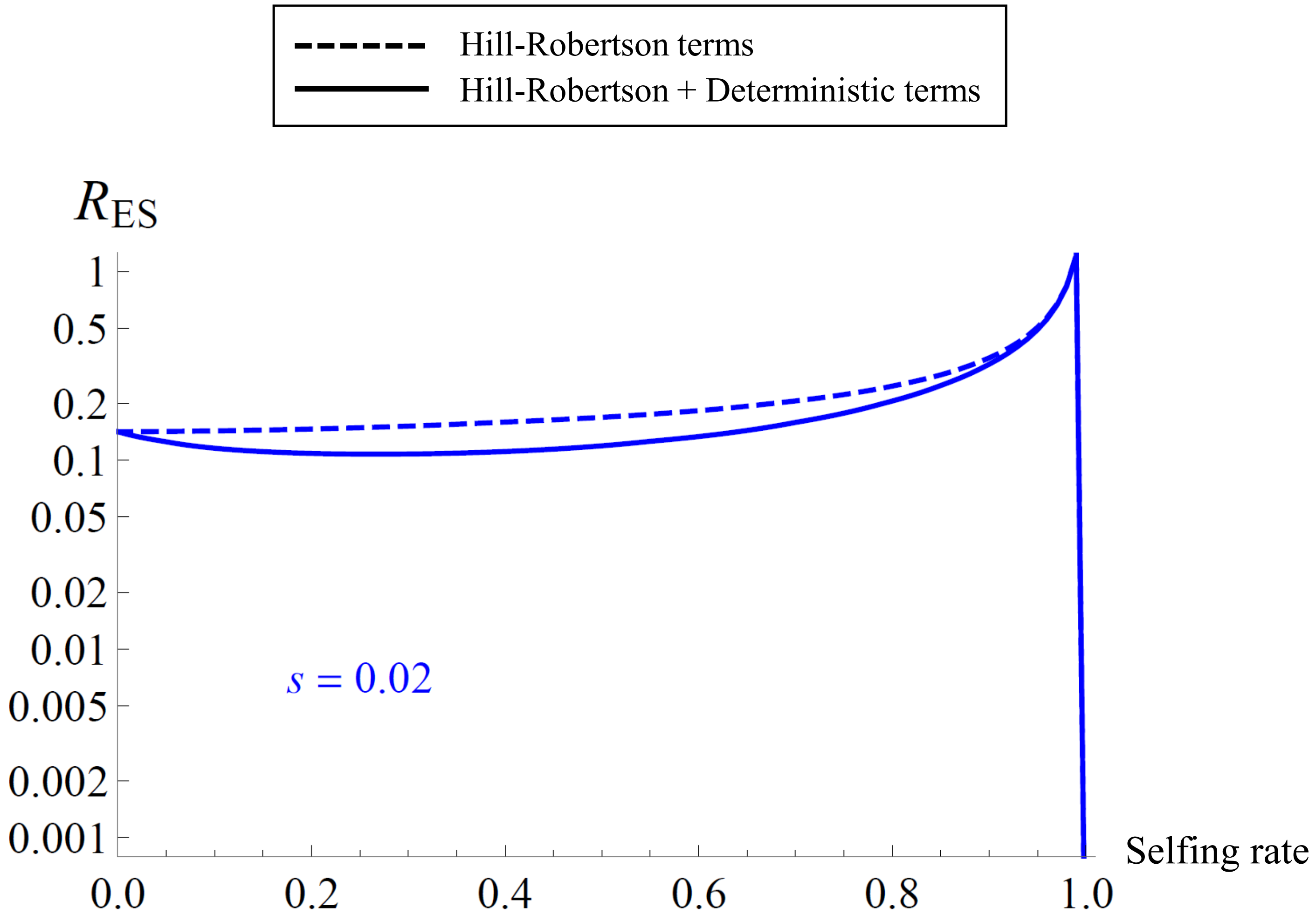


Results

Extrapolation

→ Predominance of the Hill-Roberston effect

→ Weak deterministic effect disfavoring recombination



s = selection coefficient of deleterious mutations

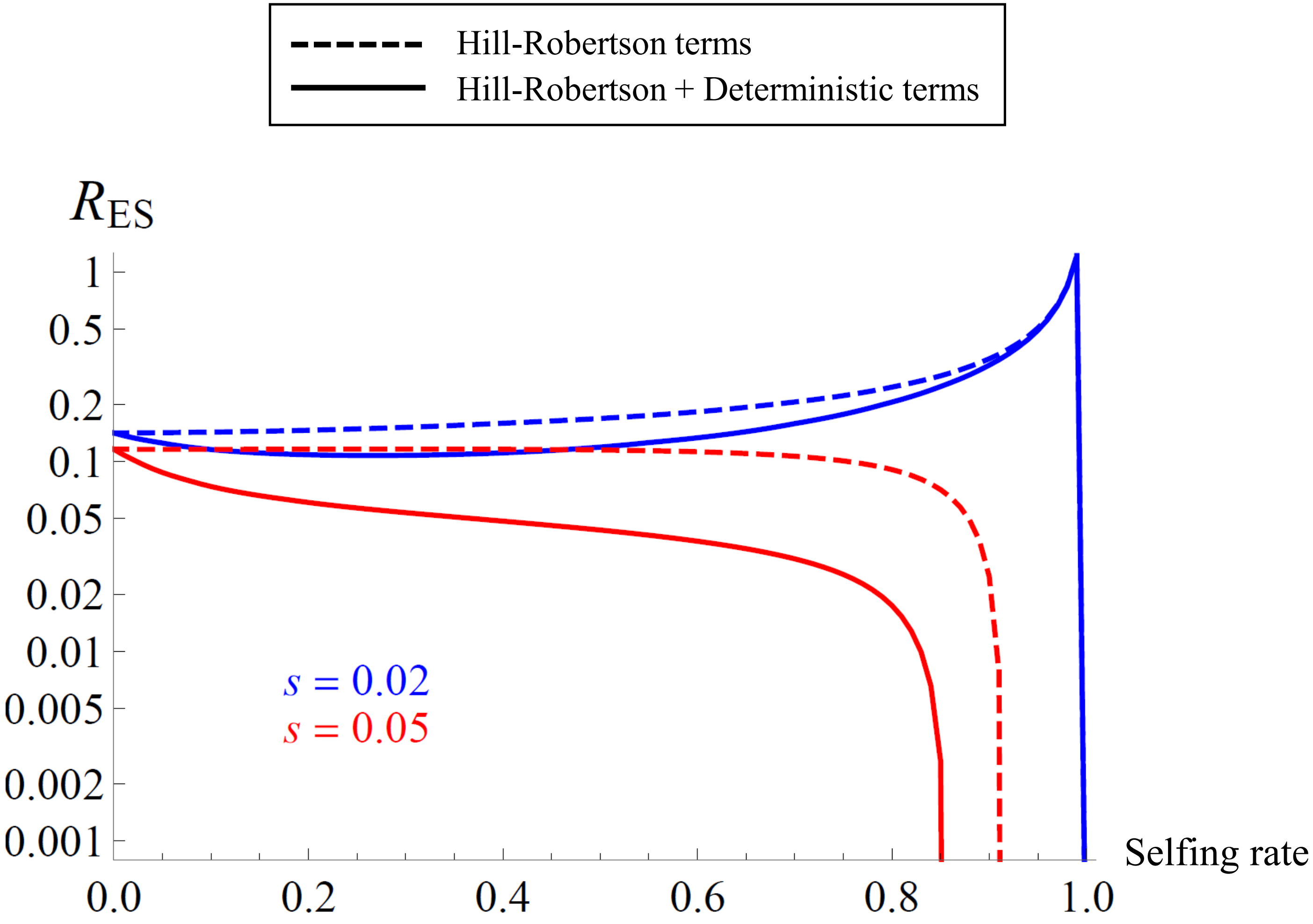
Results

Extrapolation

→ Predominance of the Hill-Roberston effect

→ Weak deterministic effect disfavoring recombination

→ Selfing increases or decreases R_{ES} according to *s* (selection against deleterious mutations)



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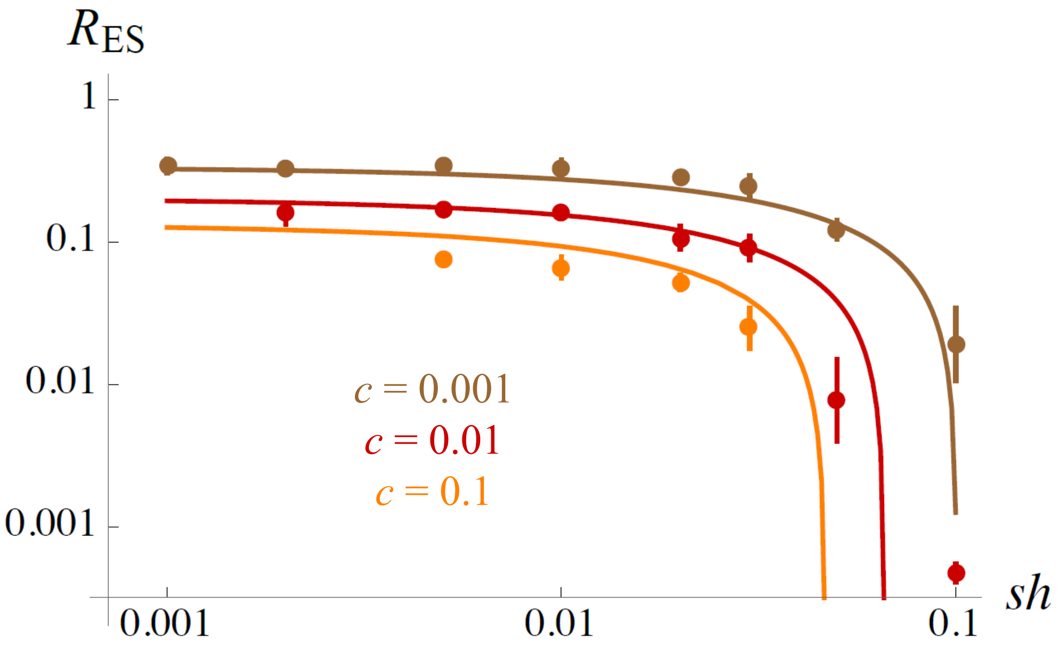
Results

Extrapolation / no epistasis

Under random mating:

→ Selection against delterious mutations = *sh*

→ Plateau in the strength of the H-R effect as long as *sh* << *R*



From Roze (in press)

c = direct cost of recombination

Results

Extrapolation

Under partial selfing:

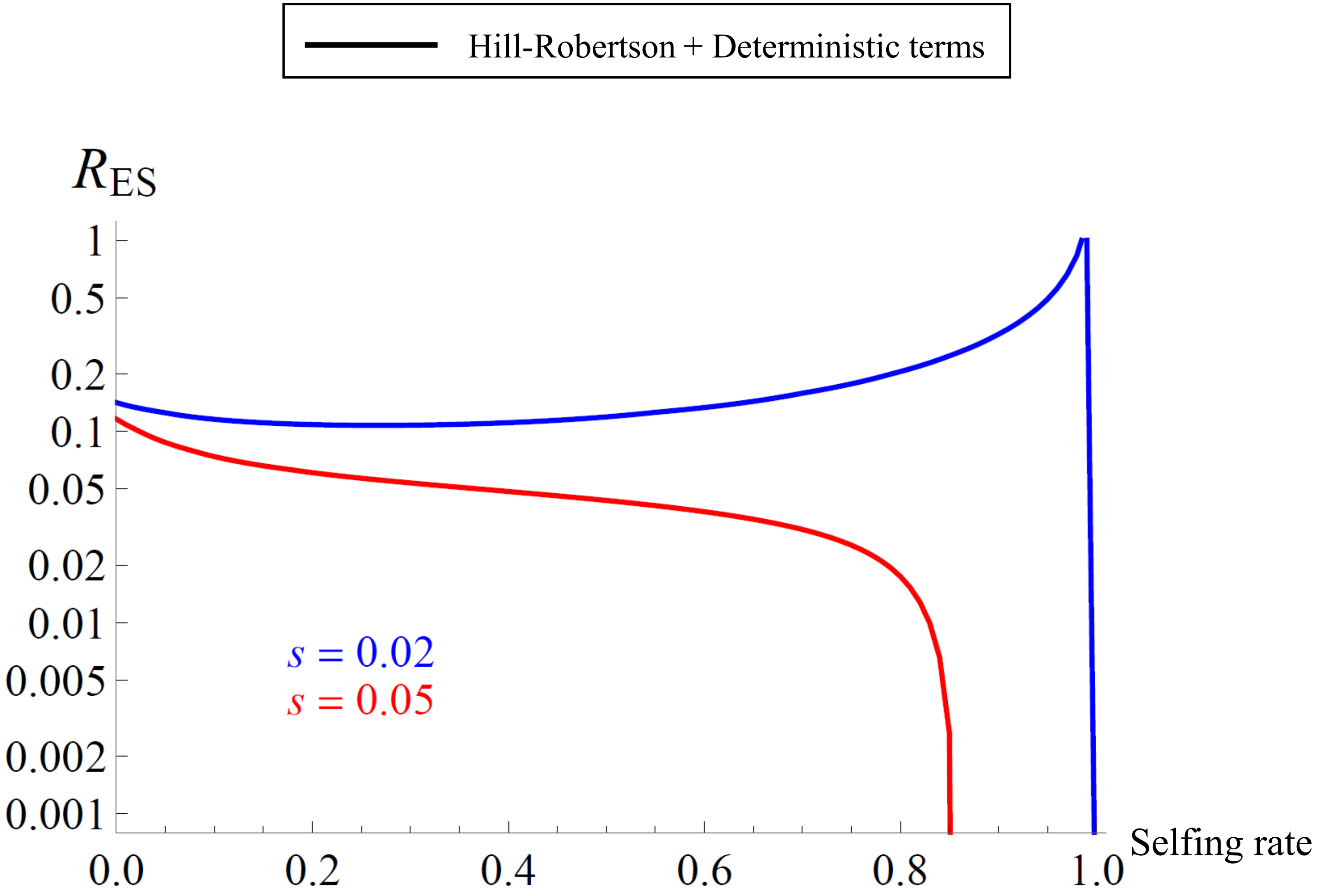
→ Selection against delterious mutations = sh_e

→ h_e , effective dominance coefficient: h under random mating, 1 under full-selfing

→ Stronger effective selection when increasing the selfing rate

→When s low => plateau of the H-R effect

→ R_{ES} increases because the efficacy of recombination is reduced (no effect under full selfing)

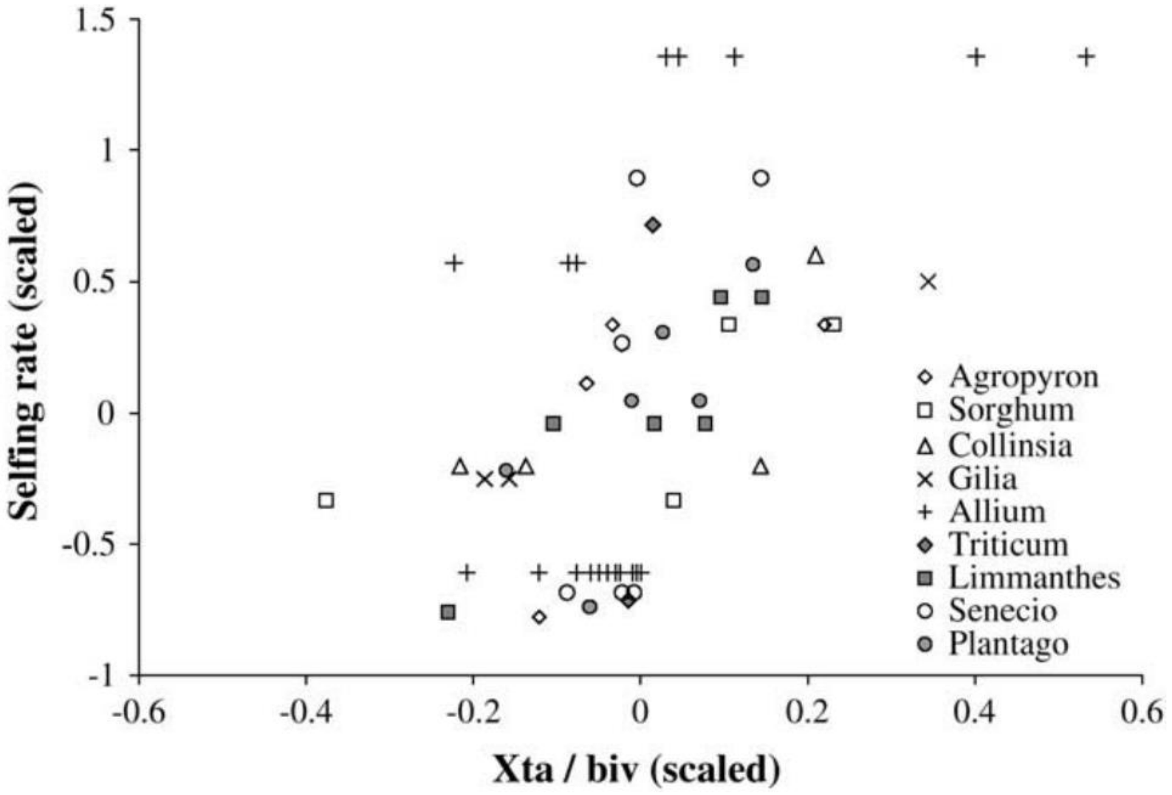


s = selection coefficient of deleterious mutations

Perspectives

→ Deleterious mutations are estimated to have weak fitness effect on average (Charlesworth, 2015): regime where selfing increases selection for recombination

→ Higher genome-wide recombination rates expected in more selfing species



Roze & Lenormand, 2005

Acknowlegments


Denis Roze (Supervisor)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Station Biologique
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Agence Nationale de la Recherche
ANR
SelfRecomb project

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