



THE UNIVERSITY
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Biotechnology and
Biological Sciences
Research Council



THE ROYAL
SOCIETY

Day 2

Quantitative Genetics: Epistatic Effects

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Bayer CropScience

AlphaSimR Implementation

- Very simple implementation
 - Additive-by-additive (AxA) effects between distinct pairs of loci
 - Limits computational demand
 - Variance component calculations need all interacting loci
- Assign magnitude of effects by relative epistatic variance
 - Epistatic variance relative to additive when $p=0.5$
 - If $p=0.5$ only additive effects contribute to additive variance
 - Otherwise additive variance includes non-additive effects

Observable Epistatic Properties

- These properties are easily observable in AlphaSimR
 - Griffing effect
 - “Conversion” of epistatic variance
 - Hybrid depression
- Other properties are not easily observable
 - Heterosis due to epistasis
 - Epistatic decay

Griffing Effect

- Half of $A \times A$ variance contributes to response to selection
 - If starting with an unselected population
- This response is transitory
 - Lost if selection stops
- Griffing effect is linked to Bulmer effect
 - Both a function of LD
- Less $A \times A$ response with subsequent rounds of selection

“Conversion” of Epistatic Variance

- AxA effects can increase additive variance
 - In subsequent generations
 - Property is due to drift
- Can contribute to long-term response to selection
 - Hard to distinguish from mutation
 - See Hill 2017

Hybrid Depression

- Hybrid depression is the opposite of heterosis
 - A cross between two populations is worse than midparent
- Can be explained by $A \times A$ effects
 - Favorable combinations exist within populations
 - Hybrids have reduced frequency of favorable combination
- Can explain why genetic distance doesn't predict heterosis
 - Action of both dominance and epistasis

Heterosis due to Epistasis

- Possible to have heterosis due to $A \times A$
 - Not likely main driver due to lack of inbreeding depression
- Other forms of epistasis would be more plausible
 - Additive-by-dominance or dominance-by-dominance
- Dominance is generally favored over epistasis for heterosis
 - Based on experimental data

Epistatic Decay

- Commonly observed in plant breeding programs
 - In crosses between elite inbred lines
- Inbred progeny mean less than midparent value
 - Not due to dominance
- Effect more severe with increased recombination
 - Recombinant inbred lines versus doubled haploids
 - Appears to reflect stabilizing selection (my opinion)

AlphaSimR Demonstration