Identifying Genetic Antagonisms

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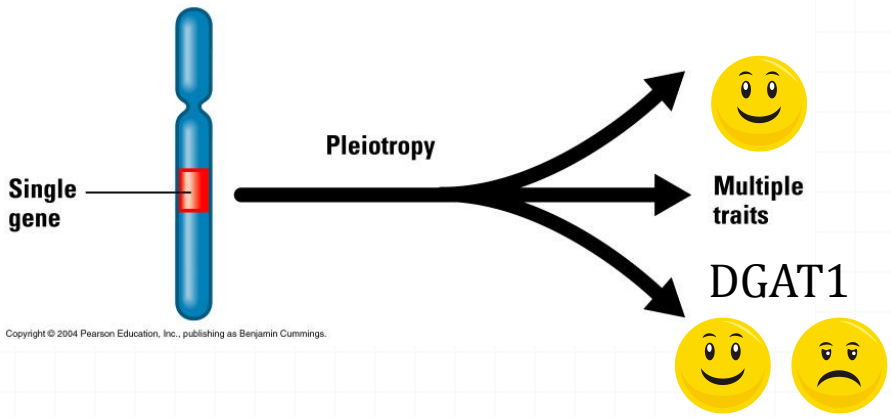
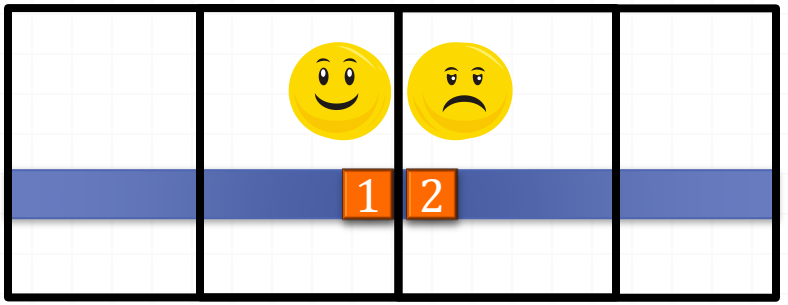
What is a Genetic Antagonism?

- Caused by plieotropy
- Could also be genes close together in the genome



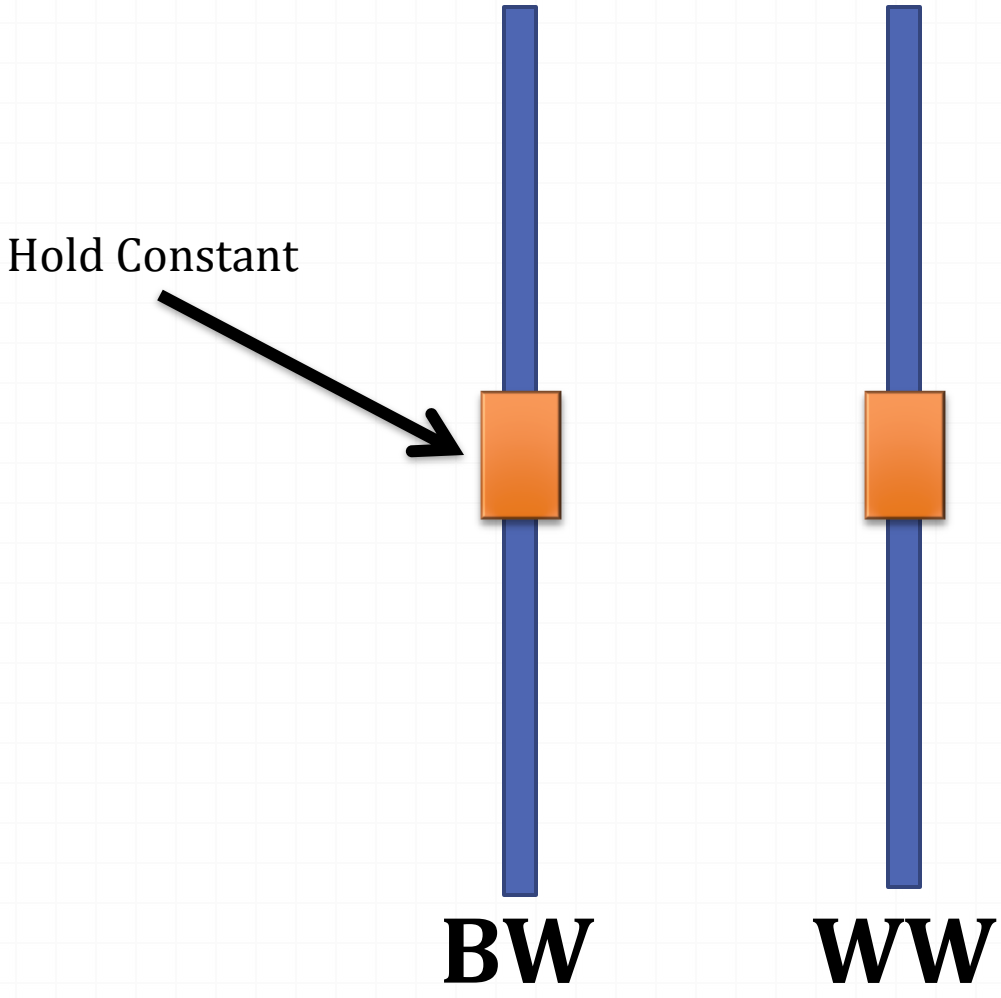
Select Alternate Alleles



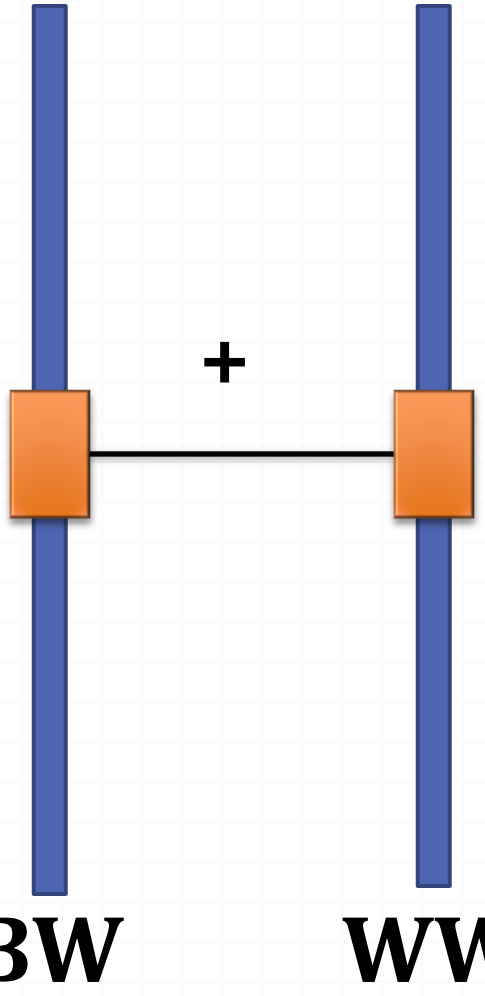
- Commonly identify them with genetic correlations

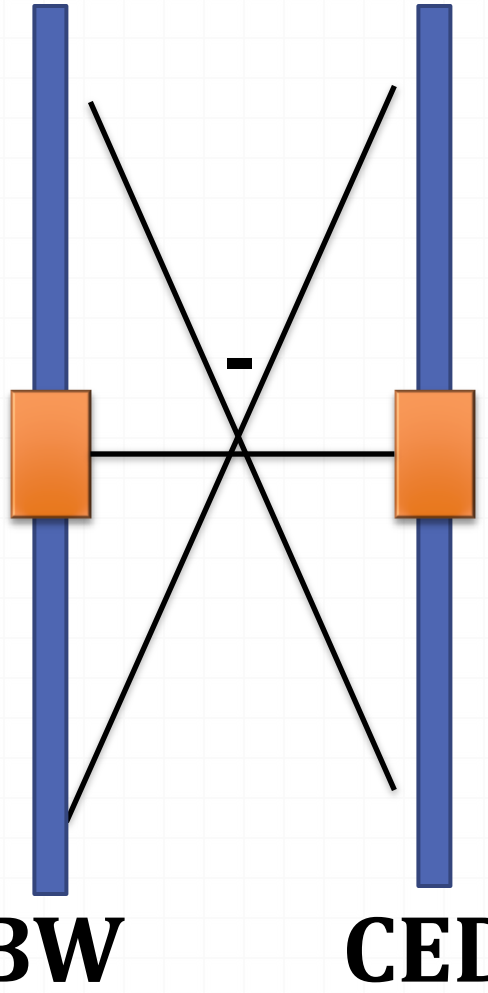
Genetic Correlations

Amount of genes in common that control two different traits:



Genetic Correlations in Practice





How Do We Describe Them?

- Can be positive or negative (direction of relationship)
  - When one changes, the other changes in the same way
  - When one changes, the other changes in the opposite way
- Can be favorable or unfavorable (whether we like it or not)
  - Does something we find desirable
  - Does something we find undesirable (genetic antagonism)
- Examples of genetic correlations
  - CED and Birth weight [negative, unfavorable]
  - Growth traits and SC [positive, favorable]
  - Milk and maintenance energy [positive, unfavorable]
  - WW and FT [negative, favorable]

Genetic antagonisms with fertility in females

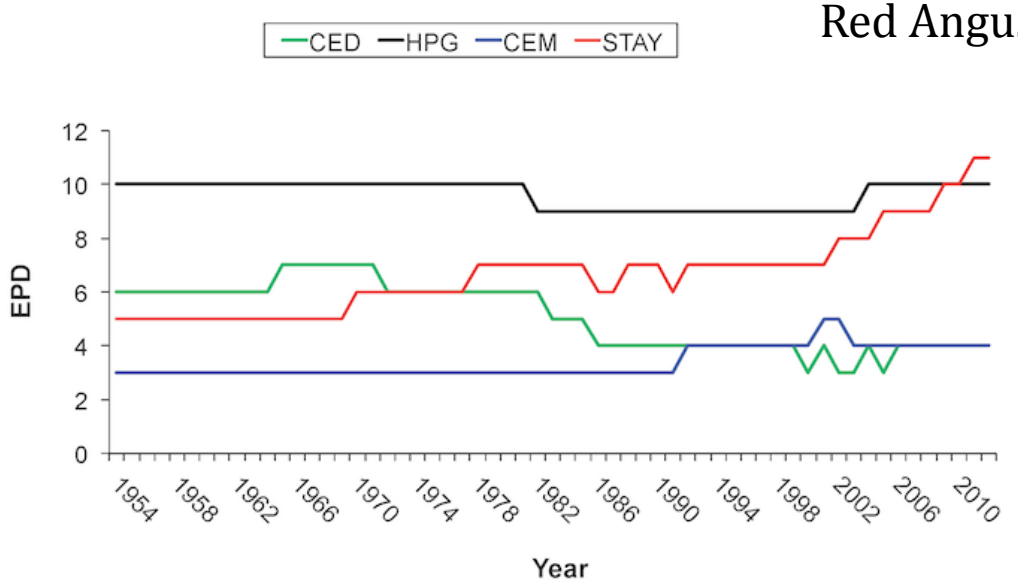
Why Fertility?

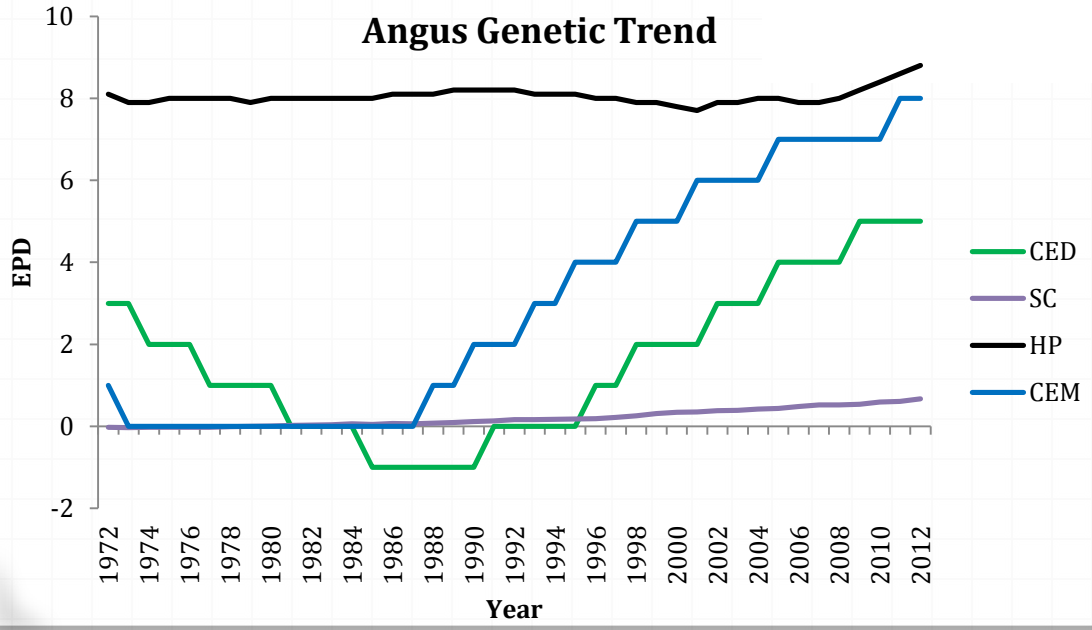
- For commercial producers, reproductive traits can be 4x more important than carcass traits (Melton 1995)
- The estimated relative importance of reproductive traits, growth traits, and end product traits is approximately 4:2:1, respectively (Schiefelbein 1998)
- It is appropriate to be concerned about fitness-related traits (fertility and longevity) when considering breeding objectives
  - Narrowly-focused on production traits
  - Dairy industry (Holsteins) is a good example
  - Accumulation of recessive lethals (fertility grant)

What About the EPDs

- What are the trends?
- Use A and RA as examples

Red Angus





- STAY
  - Positive in RA
- SC
  - + in A and estimated to be + in RA

  (Crews and Enns 2008)
- HP
  - Flat in A and RA

Why is the trend for HP flat?

- STAY and SC have been increasing, but not HP
  - Getting earlier puberty, but not greater pregnancy rates?
  - Lack of sufficient high-quality data?
  - Lack of whole-herd reporting?
  - Not selecting for HP?
  - EPD hasn't been around long enough to see long-term change?
  - Low accuracies?
  - Low heritability?
  - Sex-limited trait measured later in life?
    - Heifers: 1st breeding season
    - Bulls: 3-4 YOA
  - Genetic antagonisms with production traits?

How is Fertility Measured?

- Little agreement on how to describe the phenotype in the literature
  - Age at puberty (selection for SC?)
  - Heifer pregnancy
  - 2nd service conception
  - Days open
  - Lifetime productivity
  - Calving to first insemination
  - Calving success
  - Subsequent rebreeding
  - Stayability
  - Age at first calving
  - Average interval between successive calves
  - Calving date
  - Calving rate
  - Days from first breeding to conception
  - Number of calves born or weaned per 100 cows bred
  - Postpartum interval
  - Pregnancy rate
  - Services per conception
  - 60- to 90-day nonreturn rate

"Fertility" vs.
BW, WW, YW
Carcass Traits

Birth Weight

- Direct
  - Bourdon and Brinks 1982 (large SE)
    - BW vs. Age at 1st calving = -0.17
    - Prenatal gain vs. Age at 1st calving = -0.06
  - Burrows 2001
    - BW vs. Preg status (3 seasons) = 0.04
    - BW vs. Days to calving = 0.22
- Indirect
  - Brinks et al. 1973
    - Dystocia in heifers caused them to wean 14% fewer calves per cow exposed the following year compared to their contemporaries with no calving difficulties
  - Laster et al. 1973
    - Estrus was detected in 14.4% fewer cows that experienced dystocia during a 45 d insemination period as compared to cows that didn't experience dystocia
    - Dystocia resulted in a 15.9% lower conception rate
  - Phocas and Sapa 2004 (heritability of calving success was near 0)
    - Calving difficulty. vs. Calving success = -0.07

Conflicting results? Shorter GL or fertility?

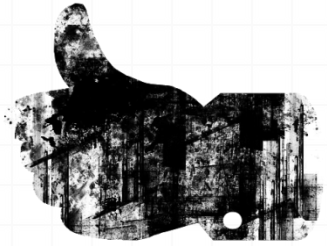
Increases in calf weight tend to lend themselves to decreased age at first calving?

Increases in calf weight that lead to dystocia are bad for fertility and profitability

Weaning Weight

- Bourdon and Brinks 1982 (Large SE)
  - WW vs. Age at 1st calving = -0.22
  - Gain to weaning vs. Age at 1st calving = -0.21
- Burrows 2001
  - WW vs. Preg Status = 0.02
  - Preweaning gain vs. Preg = 0.03
  - WW vs. Days to calving = -0.18
  - Preweaning gain vs. Days to calving = -0.27

Increases in WW and pre-weaning gain are favorable for fertility traits

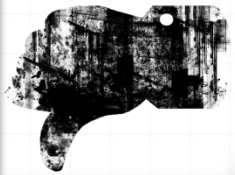


Yearling Weight

- Bourdon and Brinks 1982 (large SE)
  - YW vs. Age at 1st calving = -0.17
  - Gain to yearling (365d) vs. Age at 1st calving = -0.16
  - Age at 1st calving vs. post-weaning gain (160d) = 0
- Burrows 2001
  - YW vs. Preg = 0.01
  - YW vs. Days to calving = -0.34
  - Postweaning gain vs. Preg = 0.10
    - Cows in good condition when they wean their calves breed back well
  - Postweaning gain vs. Days to calving = -0.48
- Davis 1993
  - 400d Wt. vs. Days to calving= -0.36

Increases in YW and post-weaning gain indicate an increase in fertility

Does this lead to larger cows, which may be unsuitable for some environments?



Heifer/Cow Weights

- Phocas and Sapa 2004 (heritability of calving success was near 0)
  - Weight at 18 mo. vs. Calving success = 0.47
  - Weight at calving vs. Calving success = 0.46
- Burrows 2001
  - 18 mo. Wt. vs. Preg Status = 0.01
  - 18 mo. Wt. vs. Days to calving = -0.43
  - Cow Wt. vs. Preg Status = 0.07
  - Cow Wt. vs. Days to calving = -0.15
- Davis 1993
  - 900d Wt. vs. Calving success = -0.02

Larger mature size=less dystocia

Larger cow weights indicate a decrease in days to calving

Effects directly related to pregnancy status are very low or nonexistent

Carcass Traits

- MacNeil et al. 1984 (carcass measured on half-sib steers)
  - Age at Puberty vs. CW = 0.17
  - Age at Puberty vs. FT = -0.29
  - Age at Puberty vs. RP = 0.30
  - Conceptions/service vs. CW = 0.61
  - Conceptions/service vs. FT = 0.21
  - Conceptions/service vs. RP = 0.28

Age at puberty tends to increase with increasing CW and RP, but decreases as fat increases
Pregnancy increased with increasing CW, FT, and RP

Correlated Responses to Selection for Carcass Traits

- Selection for post-weaning gain
  - Increased age and weight at puberty, increased mature weight
  - Improved fertility
  - Reduced maternal gestation length and calving difficulty
  - Increased birth weight and reduced pre-weaning gain
- Selection for reduced BF
  - Increased age and weight at puberty, increased mature weight
  - Reduced fertility and pre-weaning gain
  - Reduced maternal gestation length, BW and calving difficulty
- Selection for increased RP or CW
  - Increased age and weight at puberty, increased mature weight
  - Improved fertility
  - Increased gestation length and BW
  - Reduced calving difficulty (due to larger size?) and maternal pre-weaning gain

MacNeil et al. 1984

Conclusions

- Most growth traits vs. fertility show weak/no antagonisms
  - Standard errors are large, even with large datasets (>2K)
  - Heritabilities are very low (most noted here were <0.1)
  - Need more research on large datasets
    - Breed associations?
- Carcass traits show some antagonisms with fat-related traits (FT, RP) and growth traits (CW and Gain)
  - Need more research with paired datasets?
  - Genetic trends and performance potential has changed
    - What does it look like now?
  - Do these relationships hold in breed association datasets?

Where do we go from here?

- Selection on HP, not just SC
  - Need more fertility selection tools
- Need more fertility studies
  - Genetic antagonisms are not clear
    - Conflicting, large SE
- Fertility grant is a great opportunity to make significant progress on a difficult trait
- Lack of complete herd data
  - Need more "effective records" (# records $*h^2$)
- Need updates on genetic antagonisms, especially carcass
- For producers:
  - May need to make management conducive to culling for fertility where genetic antagonisms are present
  - Selection indexes

Best Ways to Improve Fertility

- Non-additive genetic effects
  - Crossbreeding
- Good management
  - Nutrition
  - Culling
  - Breed to heifers to calving ease bulls
  - Keep environment and production levels in mind
- Select for HP EPDs where they are available
  - Antagonisms appear to be weak
- Look for new genomic tools that can provide additional support to traditional selection and management opportunities

Questions?