SENSITIVITY TO TEMPERATURE VARIATION IN BEEF CATTLE: OPPORTUNITIES AND CHALLENGES FOR SELECTION

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Introduction

Use of Breed Differences

Or Maybe This…

Color Matters

- Cattle with lighter colored hides tend to have lower respiration rates, decreased panting and lower body temperatures compared to black hided animals.
- Order of sensitivity to heat stress: Angus, MARC III, Gelbvieh and Charolais.

Within Breed Differences?

- Must be able to measure it
- Big challenge
- There must be variation
- Experimental opportunity
Materials and Methods

- Crossbred steers and heifers of unknown pedigree and varying percentages of Angus, Simmental, and Piedmontese (n=239) that were segregating Myostatin \((C313Y)\)
- Genotyped for \(C313Y\) and with the BovineSNP50K_v2 assay

Phenotypes Collected

- Hourly tympanic or vaginal body temperatures for at least five days.
- Monthly weight and ultrasonic rump fat, rib fat, rib eye area, and intramuscular fat percentage measurements.
- Dry matter intake measurements using the Calan gate feeding system.

Predicted body temperature across using a Fourier series during a 24-h period cold event

\[
BT_{ijklm} = \mu + M_i + G_j + S_k + M_iG_jS_k + 
\cos{24H} G_iS_k + \sin{24H} G_iS_k + 
\cos{12H} G_iS_k + \sin{12H} G_iS_k + 
\cos{24H} M_iG_iS_k + \sin{24H} M_iG_iS_k + 
\cos{12H} M_iG_iS_k + \sin{12H} M_iG_iS_k + 
\text{Animal}(k) + e_{ijklm}
\]

- Residual fitted with an autoregressive (co)variance structure
- Rump fat, body weight, and DMI not significant

Variance Components

<table>
<thead>
<tr>
<th>Group</th>
<th>Animal Variance</th>
<th>Residual Variance</th>
<th>Autoregressive Correlation Parameter</th>
<th>Repeatability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>0.052</td>
<td>0.106</td>
<td>0.79</td>
<td>0.33</td>
</tr>
<tr>
<td>Winter</td>
<td>0.073</td>
<td>0.231</td>
<td>0.78</td>
<td>0.24</td>
</tr>
<tr>
<td>Combined</td>
<td>0.063</td>
<td>0.168</td>
<td>0.78</td>
<td>0.27</td>
</tr>
</tbody>
</table>
**Results**

- Least Square Means for BT by 313Y genotype and season

<table>
<thead>
<tr>
<th>Season</th>
<th>N</th>
<th>BT (°C)</th>
<th>SE</th>
<th>Dominance</th>
<th>Additivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>79</td>
<td>39.01a</td>
<td>0.03</td>
<td>&lt; 0.001</td>
<td>0.003</td>
</tr>
<tr>
<td>Winter</td>
<td>77</td>
<td>38.47a</td>
<td>0.03</td>
<td>0.182</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

Least square means within a row with different superscripts differ (P<0.05)

**GWAS Phenotype**

- Area Under the Curve (AUC) across 5 days

**Reaction Norm**

**Genome-Wide Association BayesC**

- Winter
  - $h^2=0.21 (0.09)$
- Summer
  - $h^2=0.68 (0.11)$

- 9% of top 5% 1-Mb windows in common

Howard et al. 2014 Int. J. Biometeorology

**Interactions With Diet**

- Crossbred steers (n=480) from US Meat Animal Research Center
- Study the effects of shade and feeding zilpaterol hydrochloride (Zilmax)
- Investigation of the interaction between AUC for body temperature and the feed additive GxE?
Defining The Goals

- Selection, management or both?
- Determining pseudo phenotypes
- Use of more robust variants from growing amount of sequence data
  - "Historical" method of GS will not work for these traits

Conclusions

- Phenotypic and genetic variation exists
- Large effect mutations that impact performance could have larger interactions with environment
- Genotype by environment interactions likely exist between environmental fitness and nutritional regime (especially growth promoting additives)
  - Enough to re-rank animals?

Practical Summary

- Heat (and cold?) stress create substantial economic loss annually
  - Important problem
- Many exciting biological/statistical questions exist
  - Research and graduate training opportunities
- Deliverables to an industry are more challenging to elucidate
  - Within population selection tools vs. migration of germplasm via crossbreeding
  - Marker-based management tools vs. shade/water mitigation strategies

Profitability Focuses On The Interfaces

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