Modeling QTL Effect On BTA6 in Dairy Cattle Using Random Regression Test Day Models

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Outline

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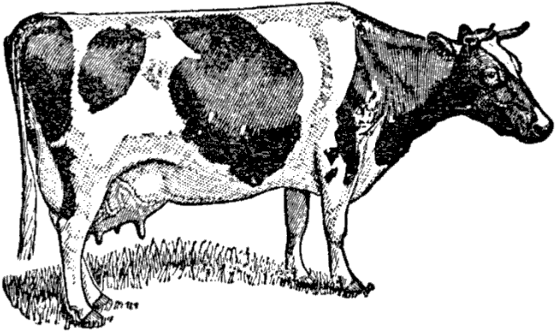
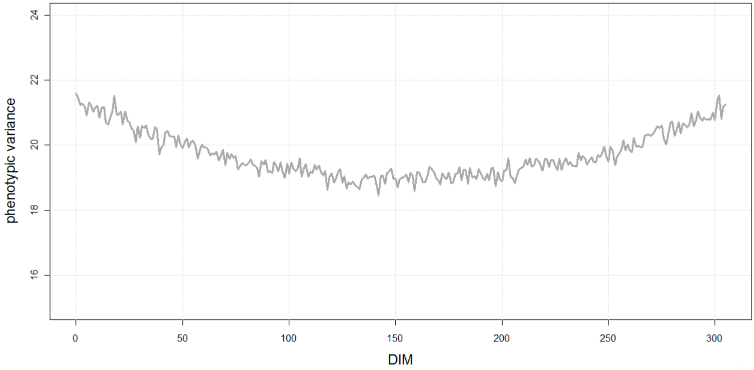
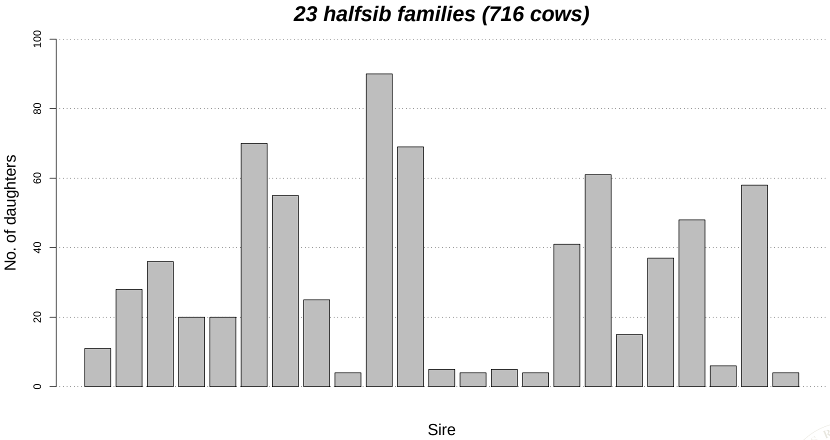


Main Aim

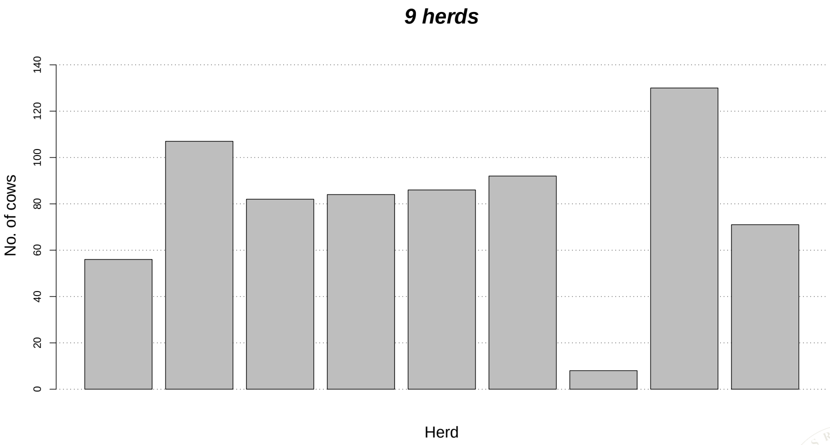
- Longitudinal data
  - correlation between observations
  - detection of QTL
  - checking if effects are constant or variable in time

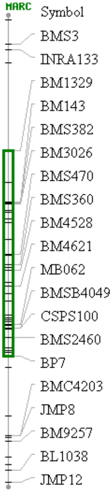


Material – animals



Material – animals





No.	Marker	Map distance (cM)	Alleles
1	BM1329	0.00	6
2	BMS2508	8.54	7
3	BMS1242	17.44	7
4	BM143	18.33	7
5	BMS518	23.57	4
6	BM4322	28.47	7
7	BMS470	32.00	4
8	ILSTS097	37.04	2
9	RM028	43.79	4
10	BM415	46.56	7
11	ILSTS035	51.87	9
12	ILSTS087	54.34	3
13	BMS2460	58.06	4
14	BP7	63.50	5

Model 1

$$y_i = \mu + \beta + \alpha_i + \rho_i + \epsilon_i,$$

where

- y_i – cumulated 305 – day milk yield for cow i
- β – fixed effects
- α_i – random additive polygenic effect, $\alpha \sim \mathcal{N}\left(0, A\sigma^2_\alpha\right)$
- ρ_i – random QTL effect, $\rho \sim \mathcal{N}\left(0, IBD\sigma^2_\rho\right)$
- ϵ_i – residual, $\epsilon \sim \mathcal{N}\left(0, I\sigma^2_\epsilon\right)$

Model 2

$$y_{ij} = \beta + \sum_{m=0}^{2} \alpha_{im}\phi_m(\tau_{ij}) + \rho_i + \sum_{m=0}^{2} \xi_{im}\phi_m(\tau_{ij}) + \epsilon_{ij},$$

where

- y_{ij} – jth test day record for individual i
- $\phi_m(\tau_{ij})$ – mth Legendre polynomial at time point τ_{ij}
- α_{im} – mth random regression coefficient for additive polygenic effect, $\alpha \sim \mathcal{N}(0, A \otimes G_\alpha)$
- ξ_{im} – mth random regression coefficient for permanent environmental effect, $\xi \sim \mathcal{N}(0, I \otimes P_\xi)$

Model 3

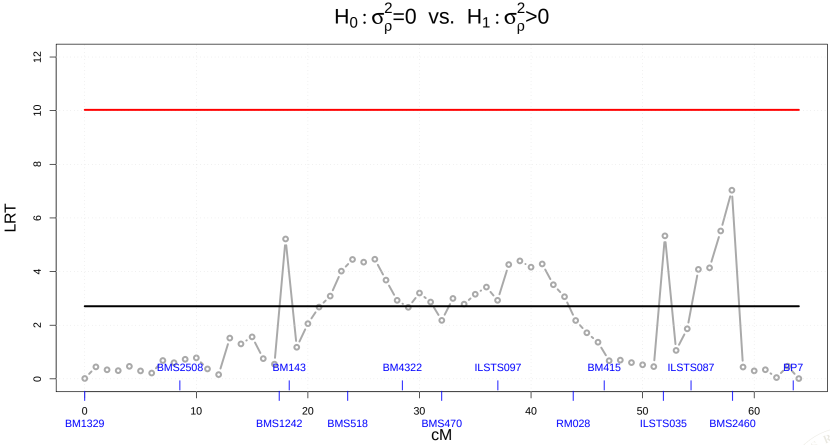
$$y_{ij} = \beta + \sum_{m=0}^{2} \alpha_{im}\phi_m(\tau_{ij}) + \sum_{m=0}^{2} \rho_{im}\phi_m(\tau_{ij}) + \sum_{m=0}^{2} \xi_{im}\phi_m(\tau_{ij}) + \epsilon_{ij},$$

where

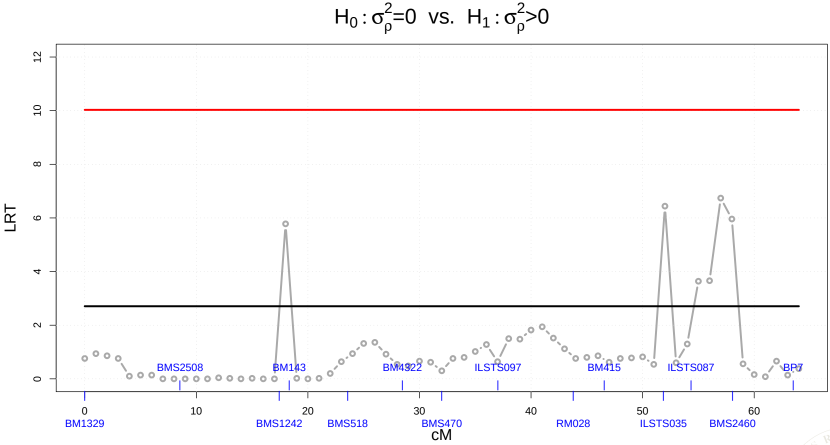
- ρ_{im} – mth random regression coefficient for QTL effect, $\rho \sim \mathcal{N}(0, IBD \otimes G_\rho)$

$$\begin{aligned} -2\log L &= \mathrm{const} + n\log\sigma_\epsilon^2 + 3\log|A| + N\log|G_\alpha| + 3\log|IBD| \\ &+ N\log|G_\rho| + N\log|P_\xi| + log|C| + y^T Sy \end{aligned}$$

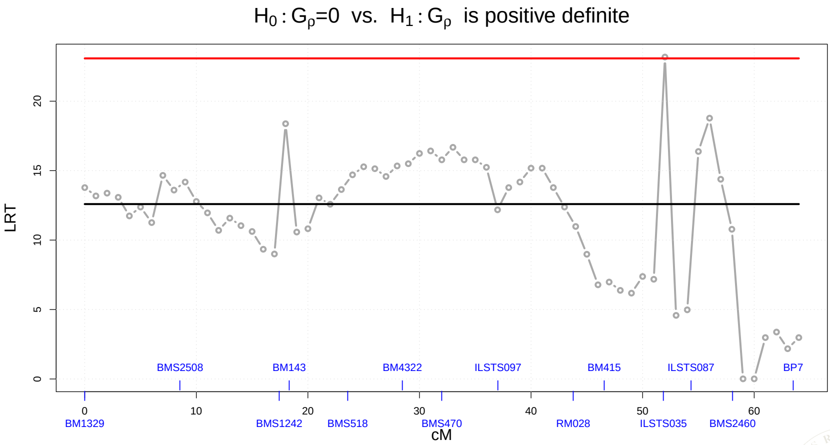
Results – Model 1



Results – Model 2

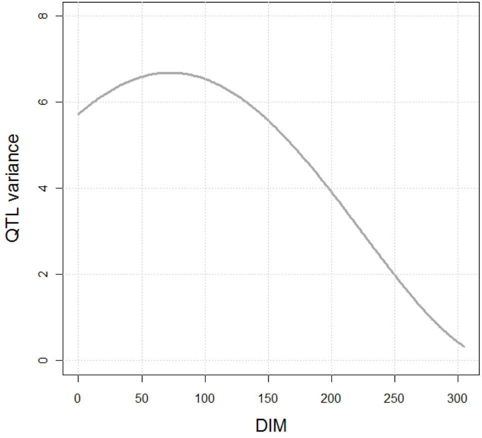


Results – Model 3



Results – Significant QTL (52 cM)

$$q_i = \Phi(\tau_i) G_\rho \Phi^T(\tau_i), \quad \text{where} \quad \Phi(\tau_i) = [\phi_0(\tau_i), \phi_1(\tau_i), \phi_2(\tau_i)]^T$$

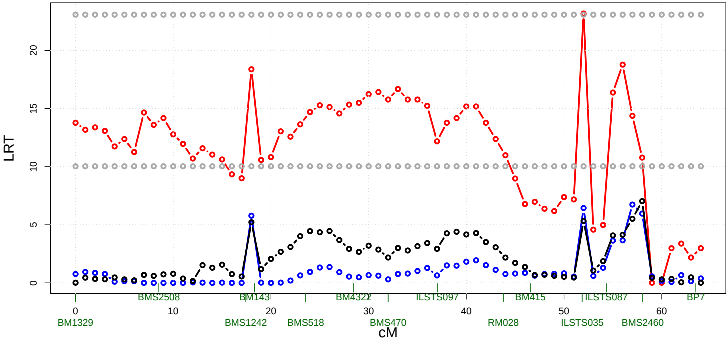


Conclusions

- Using Bonferroni correction we were able to detect only QTL at 52 cM (between markers ILST035 – ILST087).
- The other are only suggestive QTL (near markers BM143 and BMS2460 and between markers BM4322 and ILST097).
- All QTL have been reported in previous works (Spelman et al. 1996, Zhang et al. 1998 and Nadesalingam et al. 2001).
- It can be assumed that QTL effect (significant QTL) is variable in time.

Conclusions

- Position of the QTL was similar by all models, but model 3 (red line) provided the highest significance despite more parameters and thus higher critical value.



Thank You!