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MODULATING BIRTH WEIGHT HERITABILITY IN MICE

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- ✓ Selecting to decrease the sensitivity to the environment through a reduction of environmental variability, is one of the targets of selection.
- ✓ Theoretical expressions for predicting the selection response to reduce environmental variability.
  - ✓ A divergent selection experiment conducted to modify the environmental variability of birth weight (**BW**).

13 generations

MOSEVAR

- The heritability (**h²**) is considered inherent of a specific trait in a particular population.
- Expected genetic response is proportional to **h²** of the trait.

$$R = h^2 \cdot S$$

  - As a result of the environmental variability selection, the **h²** can be affected.

$$\uparrow h^2 = \frac{\sigma_a^2}{\sigma_a^2 + \sigma_e^2} \downarrow$$

  - Models assuming heterogeneity in residual variance lead to different estimations of **h²** across combinations of systematic effects.

Studying if h² for this trait could be modulated choosing the appropriate levels of the systematic effects and also by artificial selection.

Created mouse population originating from a balanced genetic contibution of:

BALB/c

C57BL

CBA

Panmixia during 40 generations ensuring:

Genetic variability ↑

Phenotypic variability ↑

↓

11 generations of a divergent selection experiment for BW

Initial population

60 ♀ x 60 ♂

(2litters)

Genetic Evaluation

(enviromental **BW** variability of their offspring)

Establishing lines

HIGH

LOW

40 ♂ and 40 ♀ offsprings from the best 10 mothers with:

↑ **u*** ↓ **u***

(predicted genetic value for **BW** enviromental variability)

40 ♀ 40 ♂

GENERATION 1

40 ♀ 40 ♂

Implementing weighed selection by:

- ✓ Allowing more descendants if mean coancestry was not increased.
- ✓ A Simulated Annealing → Optimal solution.
- ✓ Individual inbreeding coefficients control → Avoiding mating between animals which share grandparents.

15341 records
1641 litters and 1039 females

HETEROSCEDASTIC MODEL

- ✓ Pup **BW** as a maternal trait.
- ✓ Environmental variance is heterogeneous.

$$BW = x_i'b + z_i'u + w_i'c + e^{\frac{1}{2}(x_i'b^* + w_i'c^*)}\,\varepsilon_i$$

- ✓ Systematic effects: line-generation (25), sex (female, male and unknown), litter size (to 2 from 17), parity number (2).
- ✓ Random effects: direct additive genetic and litter effects.
- ✓ Classic equation

$$BW = x_i'b + z_i'u + w_i'c + e^{\frac{1}{2}(x_i'b^* + z_i'u^* + w_i'c^*)}\,\varepsilon_i$$

HERITABILITY

- Differents estimations of **h^2** for the traits.
  - residual variance (**σ^2_{ei}**) varies among systematic effects.
- Phenotypic variance (**σ^2_p**) is not unique.

$$\sigma^2_{p_i} = \sigma^2_u + \sigma^2_c + \sigma^2_{e_i} = \sigma^2_u + \sigma^2_c + e^{(\mathbf{Xb}^* + \frac{1}{2}\sigma^2_{c*})}$$

$$h^2_i = \frac{\sigma^2_u}{\sigma^2_u + \sigma^2_c + \sigma^2_{e_i}} = \frac{\sigma^2_u}{\sigma^2_u + \sigma^2_c + e^{(\mathbf{Xb}^* + \frac{1}{2}\sigma^2_{c*})}}$$

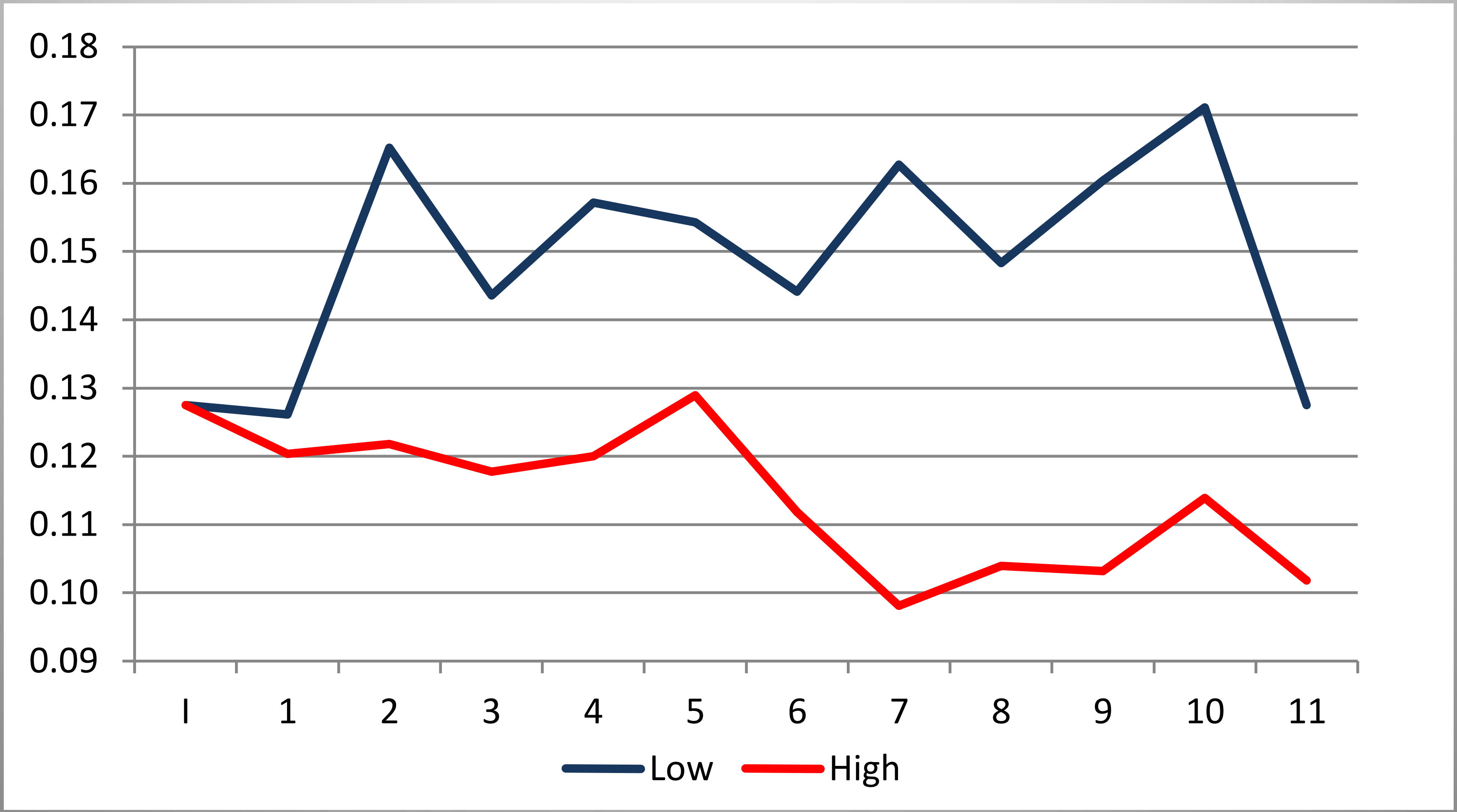
HERITABILITY

- Specific σ^2_{esl} can be also estimated for particular level ***l*** of a systematic effect ***s***.
- All the solutions were averaged within systematic effect: $\sum_{j=1,n_{sj}} \frac{\hat{b}^*_{ij}}{n_{sj}}$
- Next, for a particular desired level ***l*** of a particular systematic effect ***s***, the solution for this level was added to the means for all the other systematic effects: $\sum_{i=1,n_s}^{i\neq s}\left(\sum_{j=1,n_{sj}} \frac{\hat{b}^*_{ij}}{n_{sj}}\right) + \hat{b}^*_{sl}$ (this is an estimable function)
- σ^2_{esl} for a particular level ***l*** of a systematic effect ***s*** was:

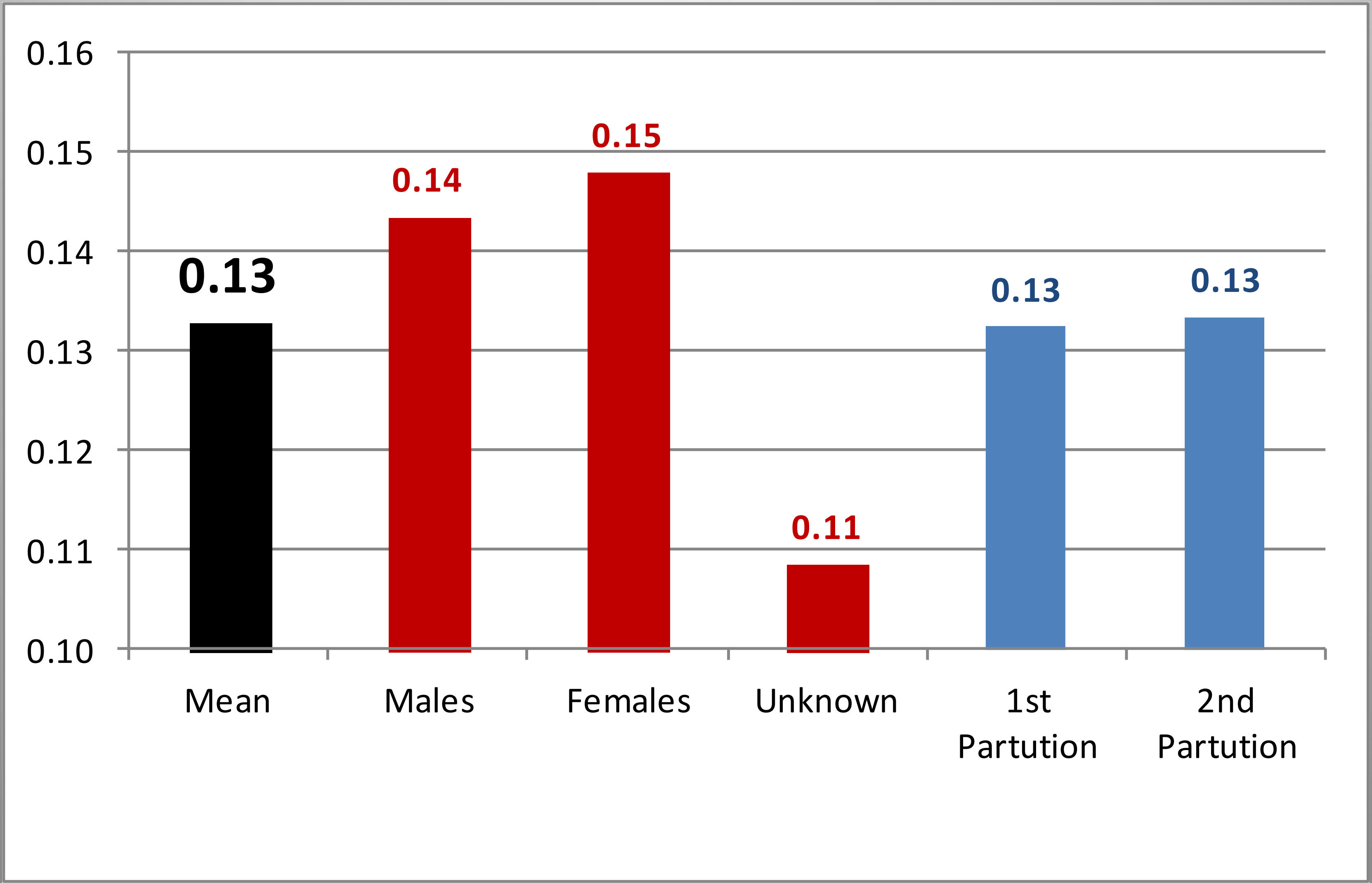
$$\sigma^2_{e_{sl}} = e^{\sum_{i=1,n_s}^{i\neq s}\left(\sum_{j=1,n_{sj}} \frac{\hat{b}^*_{ij}}{n_{sj}}\right) + \hat{b}^*_{sl} + \sigma^2_{c*}/2}$$

$$h^2_{sl} = \frac{\sigma^2_u}{\sigma^2_u + \sigma^2_c + \sigma^2_{e_{sl}}}$$

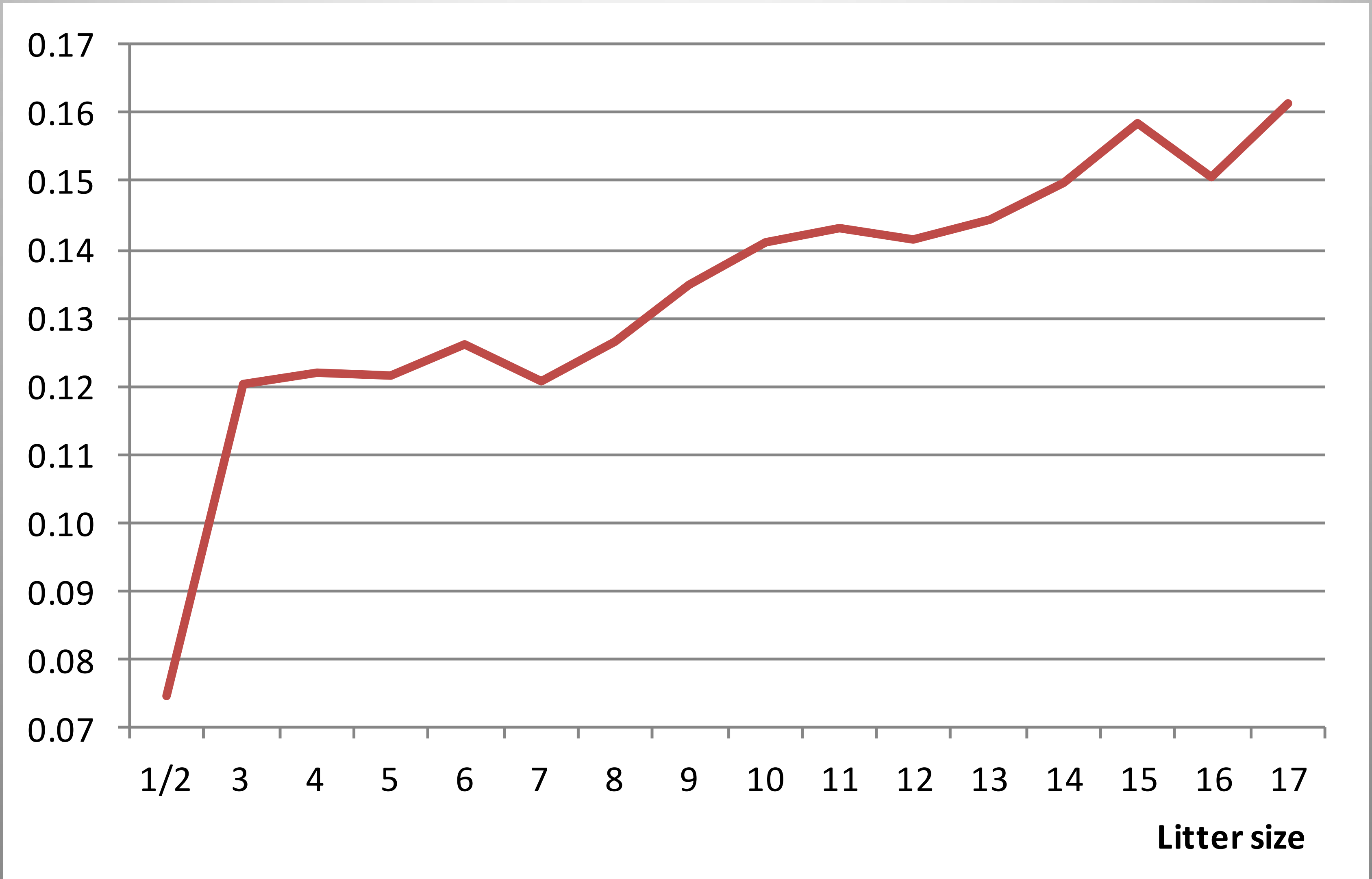
Birth weight heritability across generations within lines



Birth weight heritability averaged and according to different levels of sex and parturition effects



Birth weight heritability estimated regarding litter size



IMPORTANT RESULTS REGARDING SYSTEMATIC EFFECTS

h^2

- ✓ Increases when litter size does
- ✓ Decreases if we do not consider the sex
- ✓ Does not vary with parity number

Modulating the heritability for birth weight seems to be possible

- ✓ selecting to decrease the environmental variability
- ✓ choosing the appropriate levels of the systematic effects

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Thank you for your attention!