

Detecting variance-controlling QTL

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AN EXPERIMENTAL CHECK ON QUANTITATIVE
GENETICAL THEORY

II. THE LONG-TERM EFFECTS OF SELECTION

BY G. A. CLAYTON AND ALAN ROBERTSON*

Institute of Animal Genetics, Edinburgh

(With Eight Text-figures)

(Received 29 March 1956)

Clayton & Robertson (1957)
Journal of Genetics 55:152-165

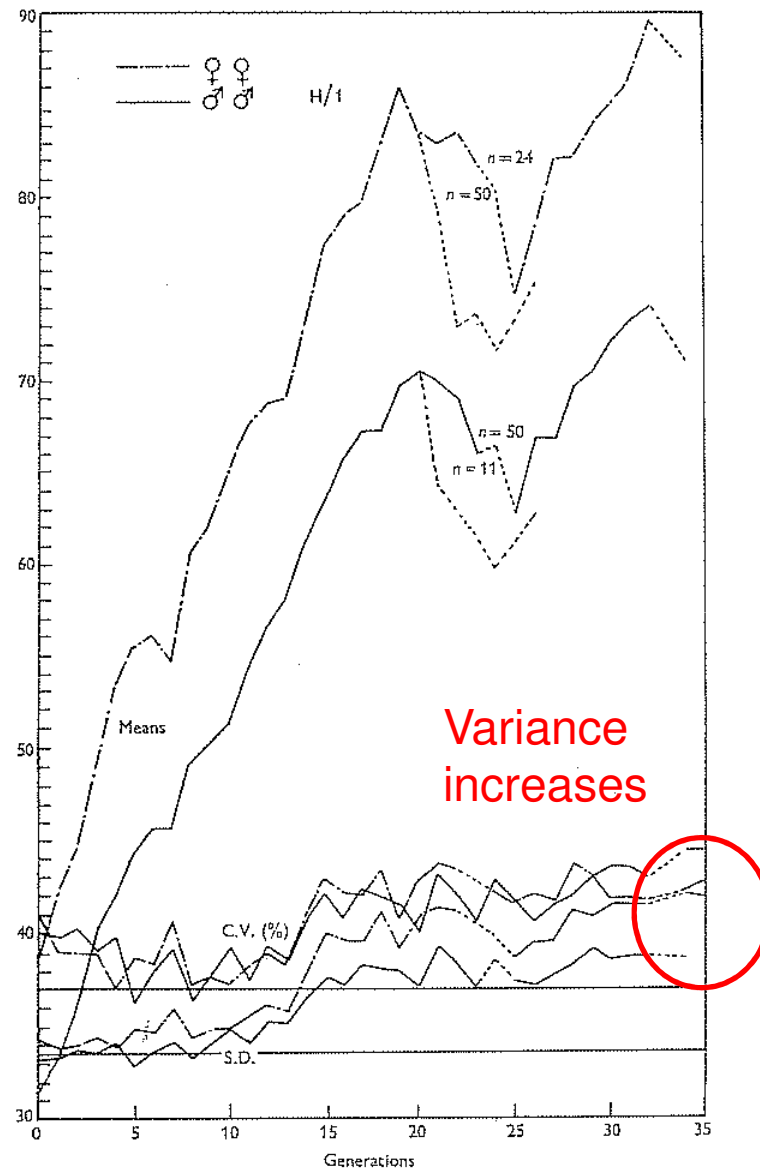


Fig. 6. Response and variation in H 1.

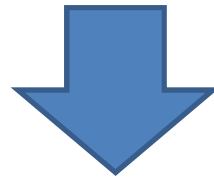
Table 4. Mean and variance of the progeny of parents selected in order of bristle number (H 1)

Wild line

Natural selection is often stabilizing
=> Individuals with genes minimizing environmental variance will have a selective advantage

Domestic line

Directed artificial selection
=> Individuals with genes increasing environmental variance will have a selective advantage



**There should exist
variance-controlling
QTL in wildxdomestic
intercrosses**

Statistical model for detecting variance-controlling QTL

$$y = Xb + ax_a + dx_d + e$$

x_a, x_d = Haley-Knott regression coefficients

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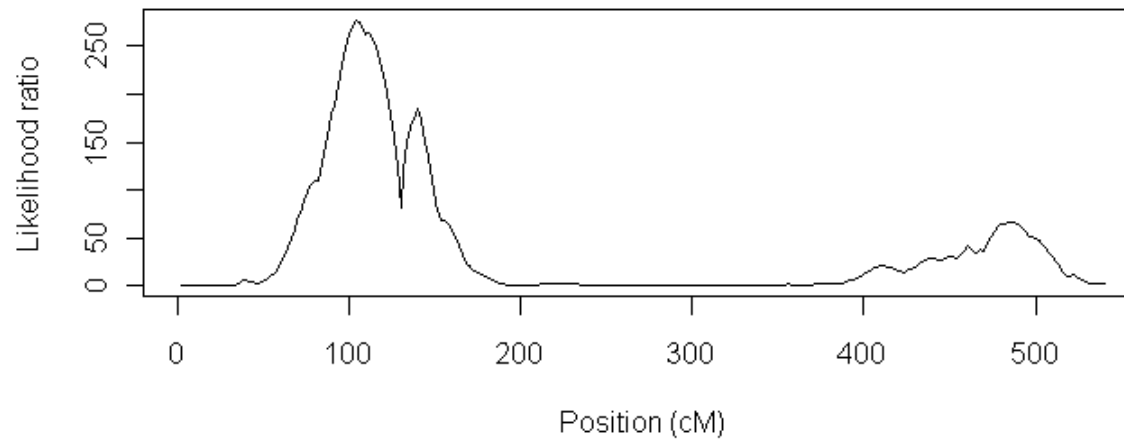
x_a, x_d = Haley-Knott regression coefficients

Analyze the **squared residuals** with a generalized linear model having a **gamma distribution** and **log link**:

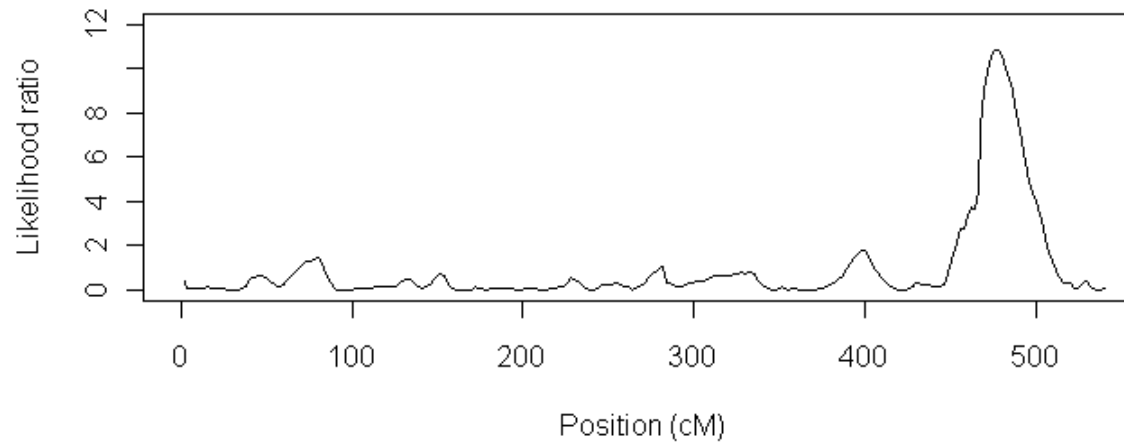
$$E(e_i^2) = \mu$$

$$\log(\mu) = Xb_v + a_v x_a + d_v x_d$$

QTL controlling the mean of body weight



QTL controlling the variance of body weight

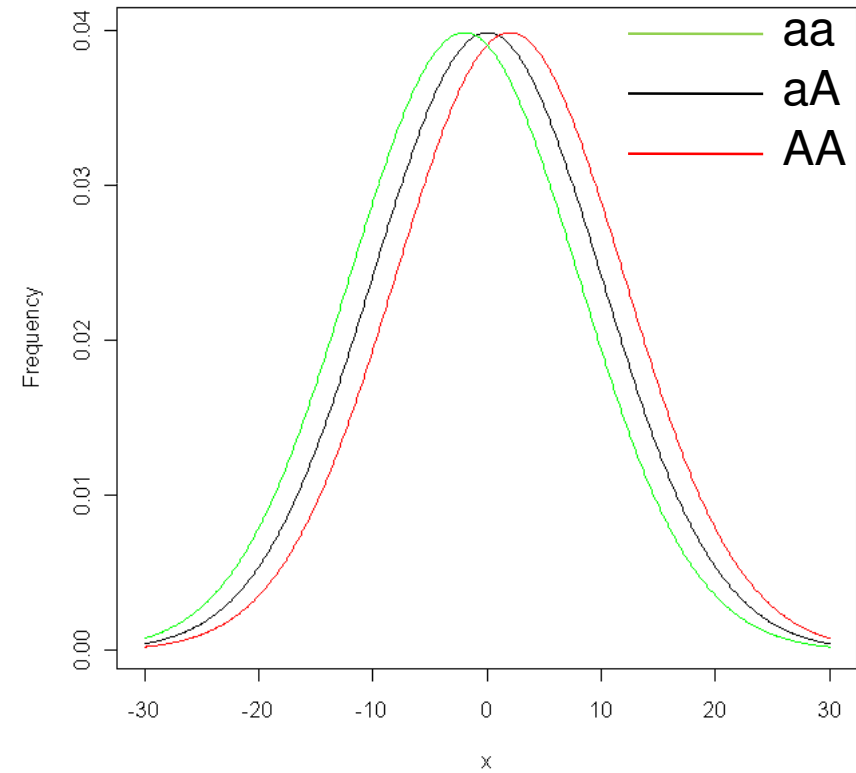


Simulation setup

- 800 F2
- 1000 replicates
- Three cases:
 - Mean-controlling QTL
 - Variance-controlling QTL
 - QTL controlling both mean and variance

Mean-controlling QTL

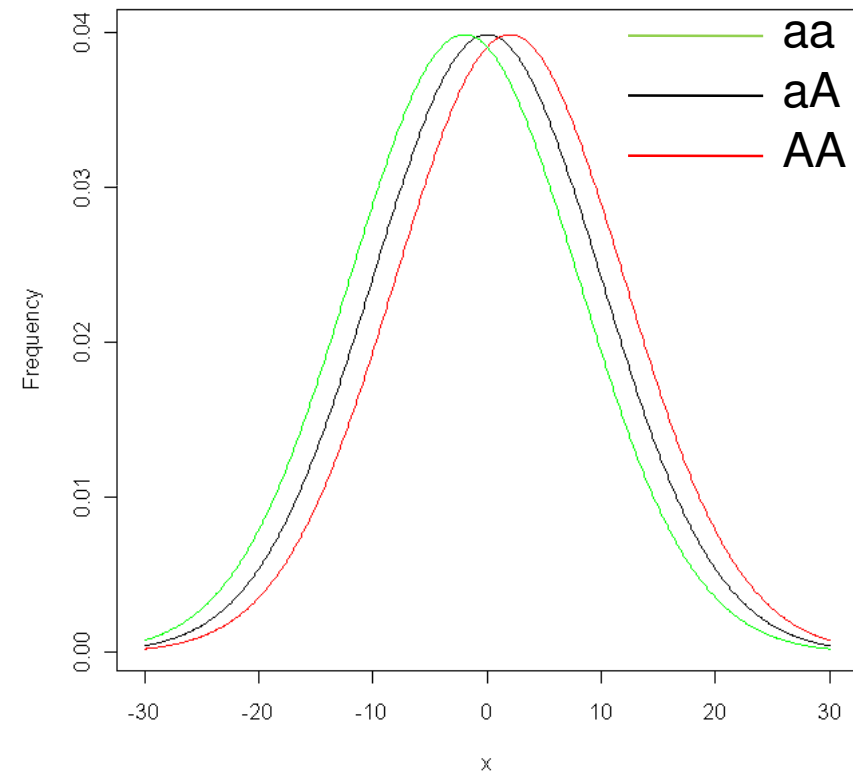
Phenotypic distribution of individuals with aa, aA and AA genotypes



Mean-controlling QTL

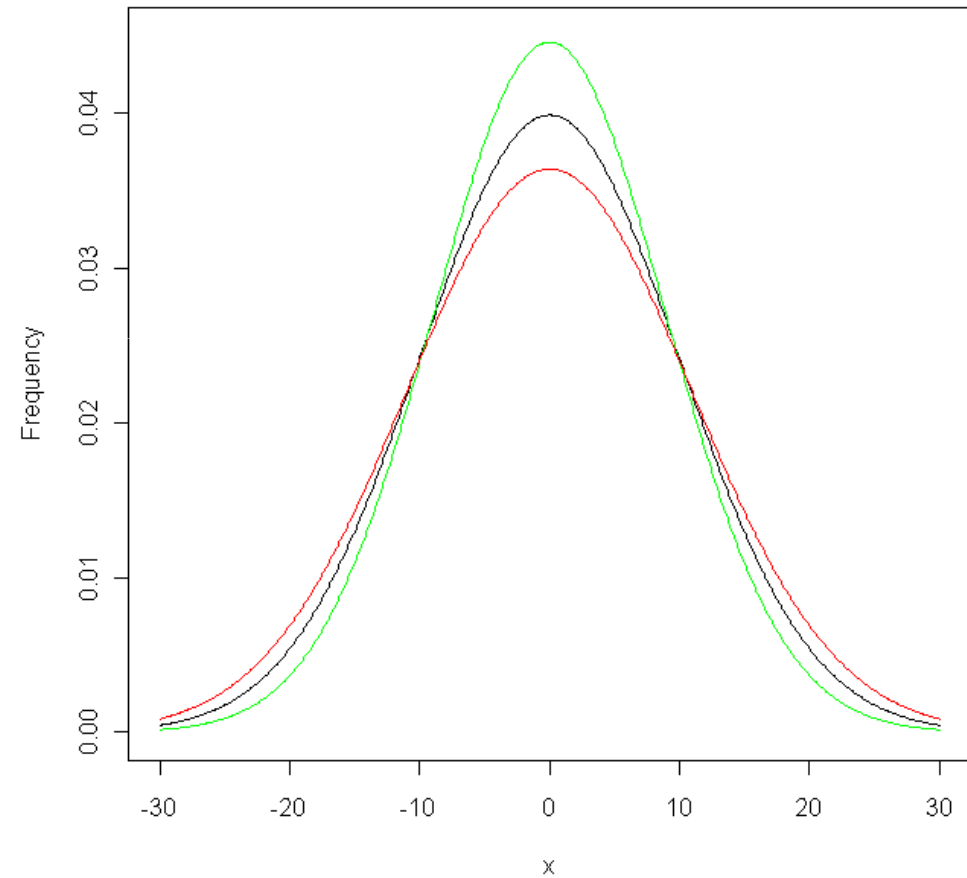
Power to detect mean-controlling QTL at 5% significance = **47%**

Phenotypic distribution of individuals with aa, aA and AA genotypes



Variance-controlling QTL

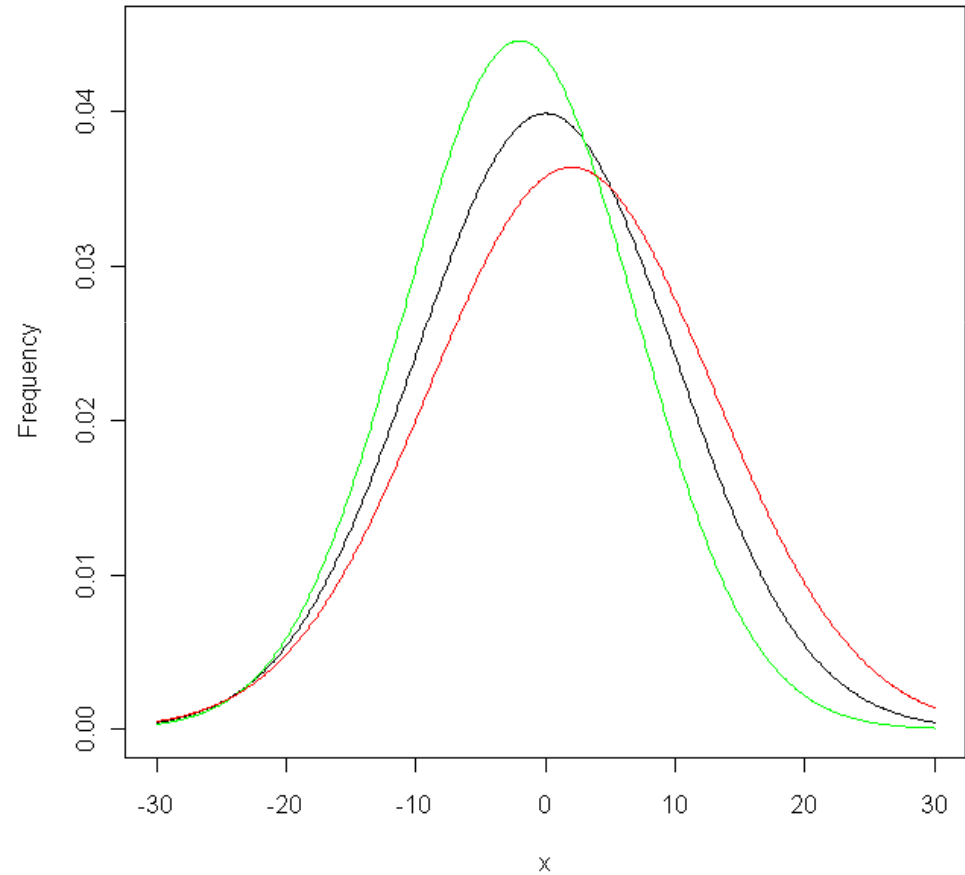
Power to detect variance-controlling QTL at 5% significance = **31%**



Mean and variance controlling QTL

Power to detect mean-controlling QTL at 5% significance = **48%**

Power to detect variance-controlling QTL at 5% significance = **32%**



Some interesting results
and
Some words of caution

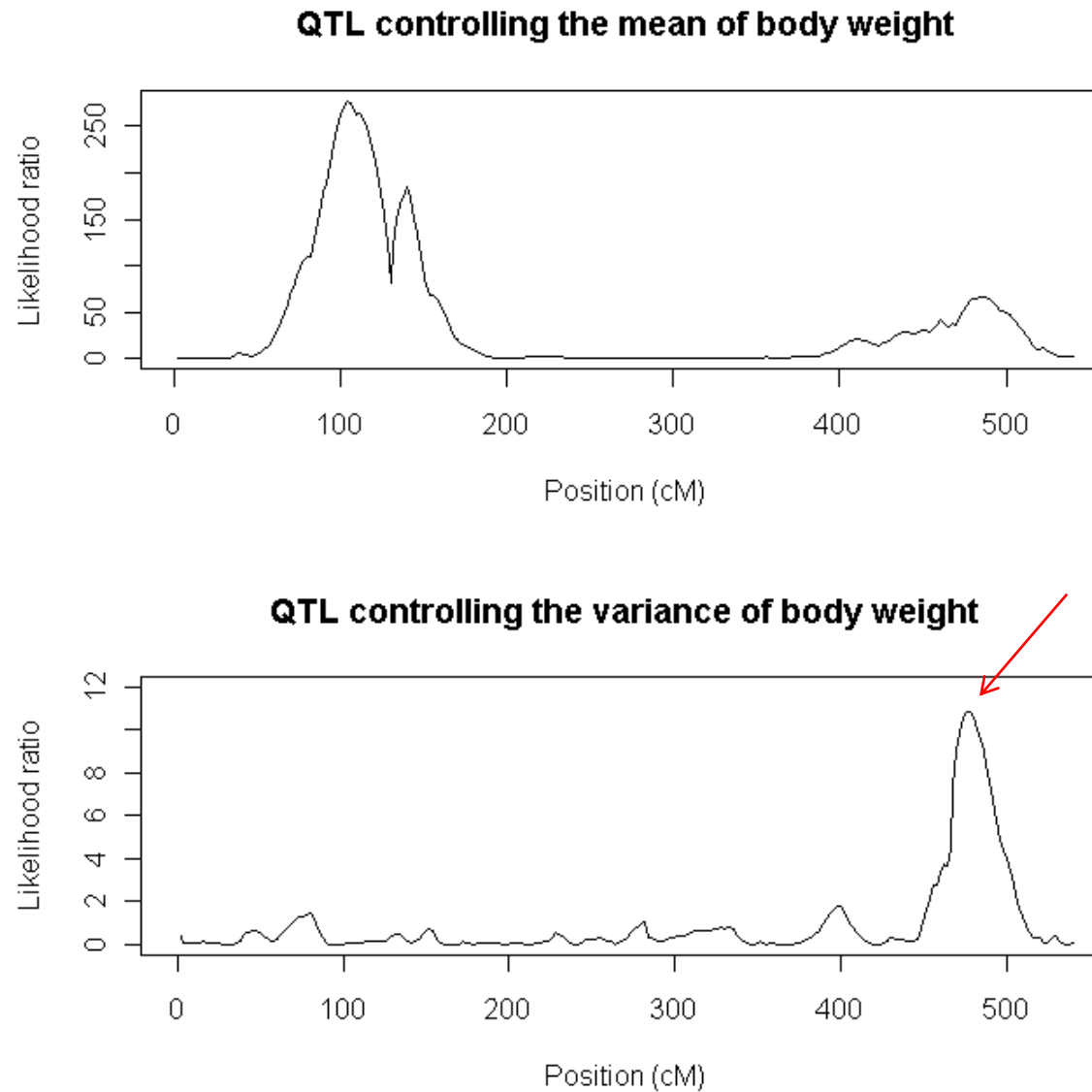
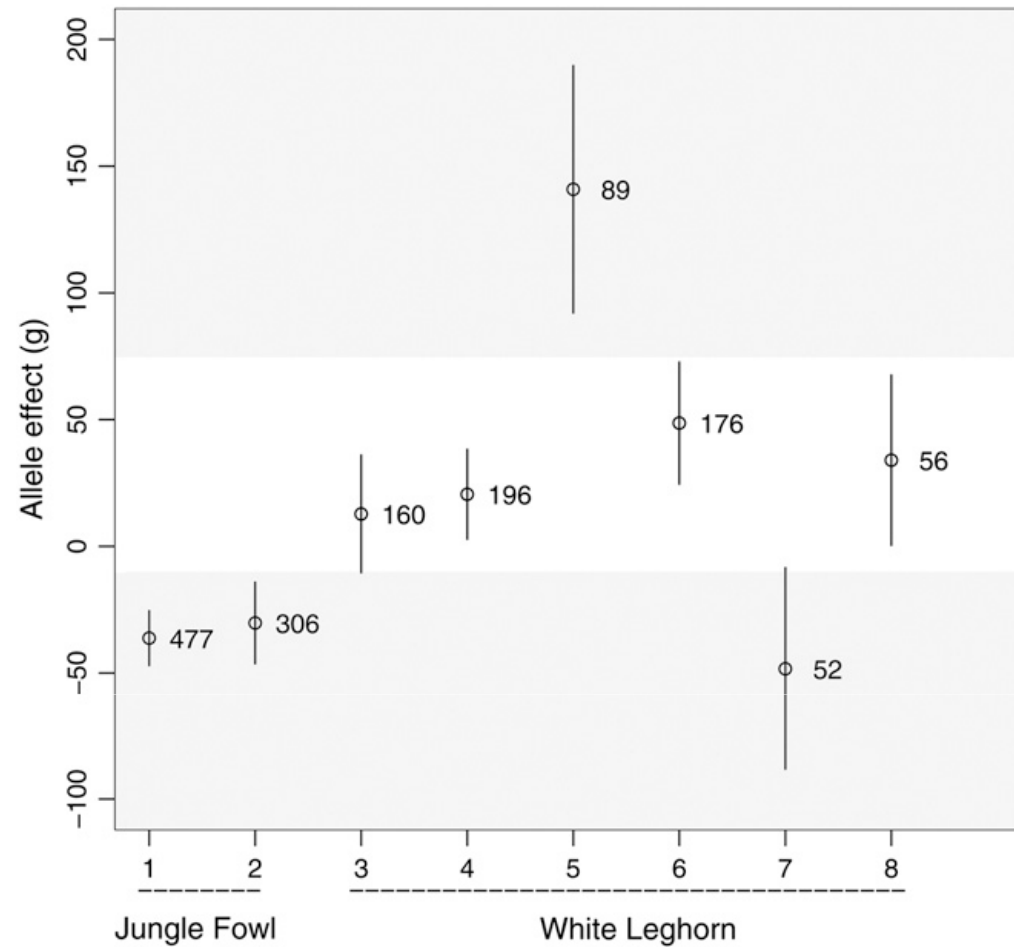


Figure 1 Scan for QTL controlling the mean (top figure) and the variance (bottom figure) of body weight at 200 days of age on chicken chromosome 1. Jungle Fowl x domestic Leghorn intercross with 800 F2.

Rönnegård et al.
(2008) *Genetics*
178: 2315-26.



Estimated base generation allele effects for Growth 2 on chromosome 1 in the Red Jungle Fowl x White Leghorn F2 intercross (body weight at 200 days).

The numbers indicate the expected number of copies of the founder alleles in the F2 generation. The shaded regions show the clustering of the suggested triallelic QTL.

Conclusions

- There should exist variance-controlling QTL in domestic-wild intercrosses
- We have the statistical tools to find these
- We should have the power to find variance-controlling QTL with this method
- A combined analysis together with FIA should be made