Exercise Inheritance of variability

1. **Absence of heritability of variability.** Consider the classical model P = A + E, in which Var(E) does not show any heritable variance. Suppose that we would want to decrease variability among animals. This could be done by producing a population of individuals descending from a mating of a single fully inbred sire with a single fully inbred dam. Suppose that heritability equals 0.3. Calculate *i*) the genetic variance in the offspring, and *ii*) the proportional reduction of phenotypic standard deviation in the offspring, compared to the ordinary population.

2. **Heritable variability.** Consider the additive model for inheritance of variability (Hill and co-workers). Suppose that we have Var(A_M) = 0.3, and Var(E) = 0.7 when A_v = 0. Calculate phenotypic variance in a population consisting of genetically identical clones having A_v = 0.1.
3. For the same inputs as in question 2, calculate the within half-sib family phenotypic variance for a family descending from a sire having A_v = 0.1. (Hence, no longer consider the clone, but an outbred population). Are the offspring of this sire more or less variable than offspring of the average sire?
4. What is the (approximate) breeding value for variance of the sire mentioned in question 3, when expressed in terms of the exponential model?
5. Suppose that the variance of environmental variance in the above population equals Var(A_v) = 0.01 in the additive model. Express this variance in terms of the exponential model.
6. Suppose that Var(E) = 0.7 and Var(A_v) = 0.01 in the additive model. Calculate the genetic coefficient of variation of the variance, GCV_v, from the values for the additive model.
7. Calculate the genetic coefficient of variation of the variance, GCV_v, from the corresponding values for the exponential model.
8. Do we have good opportunities to change the mean environmental variance by means of selection? How do you judge that?
9. Now consider the standard deviation, rather than the variance. Calculate the GCV_v for the standard deviation. What do you conclude with respect to the opportunities to reduce the standard deviation?
10. Following-up question 8, suppose that we would have an accuracy of 0.5 and a selection intensity of -1 for the variance. Calculate the relative reduction in mean environmental variance that we'd achieve in this case.
11. For the population in question 6, suppose that we attempt to reduce variability by selecting animals with the lowest P^2. The best we can do is to take only animals with a precisely average trait value, not selecting any individual from the tails of the distribution. What is the maximum selection differential that we can get? (Note Var(P) = 1 and assume that P_{avg} = 0 before selection). (Just try common sense, rather than looking up an equation.)
12. Calculate the heritability of the variance, h_v^2.
13. Calculate accuracy and response to selection for the situation in question 11. (Use Var(E) = 0.7 and Var(A_v) = 0.01, and take the expressions for accuracy from the notes.) Note that h_v^2 can be interpreted as a regression coefficient, so that response can be calculated as $R = h^2S$. Can we obtain large response when selecting against P^2?

14. Suppose that we are not interested in changing the variance, but merely in improving the mean trait value by classical phenotypic mass selection. Suppose that the above genetic parameters apply and that there is no genetic correlation between mean and variance, $corr(A_m, A_v) = 0$. Do we expect to see any response in Var(P)?